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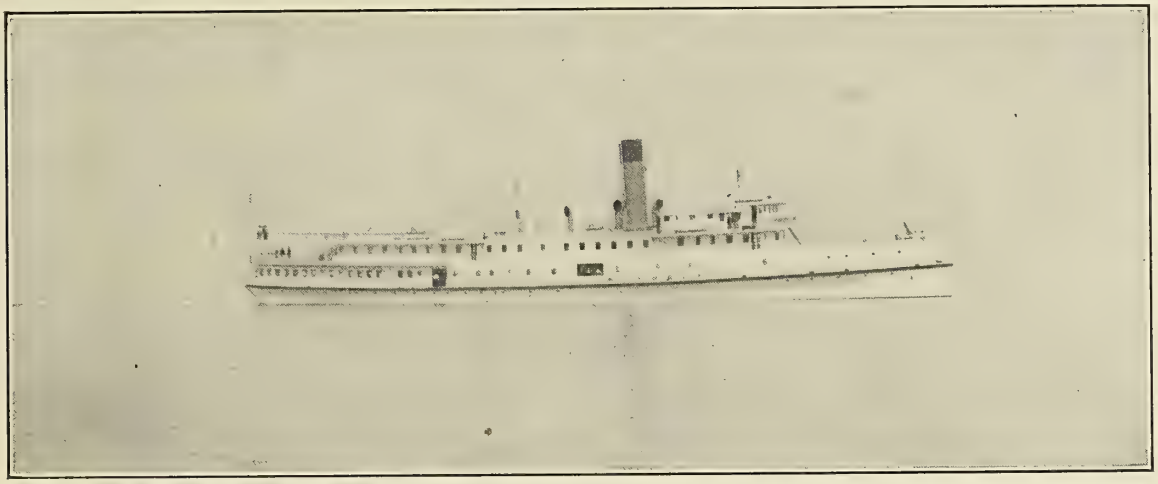
International Marine Engineering

NOVEMBER, 1907.

THE STEAMER MARYLAND.

Recently completed at the works of the Maryland Steel Company, at Sparrows Point, Md., is the steamer *Maryland*. She is a twin screw steel transfer boat for the N. Y. P. & N. R. R. Co., and is to run between Cape Charles and Norfolk. In general appearance and arrangement she is similar to the *Pennsylvania* of the same line, now in service, except for the engines and condensers, which will be described below.

The new steamer is a handsome, ship-shaped vessel, with the usual steamboat superstructure, a well proportioned funnel and a pleasing amount of sheer. Her chief point of peculiarity or difference from other vessels engaged in similar service is that she has a modified torpedo boat or knuckle stern. This differs from the regular torpedo boat stern in that there are practically two sterns divided at the middle, as is easily seen in the outward profile and the small sketch of the stern. This is done to keep water under the stern for the propellers while the vessel is crossing shoals near Cape Charles.



THE MARYLAND MAKES VERY LITTLE DISTURBANCE IN RUNNING THROUGH THE WATER.

The *Maryland* is designed to be one of the speediest and most comfortable boats around Hampton Roads, and from all indications she will greatly exceed these expectations. Her chief dimensions are:

	Ft.	Ins.
Length overall	259	9½
Length between perpendiculars	249	6⅞
Beam molded at deck	40	
Depth molded	15	3½
Mean draft	9	4
Speed	18 knots.	

HULL.

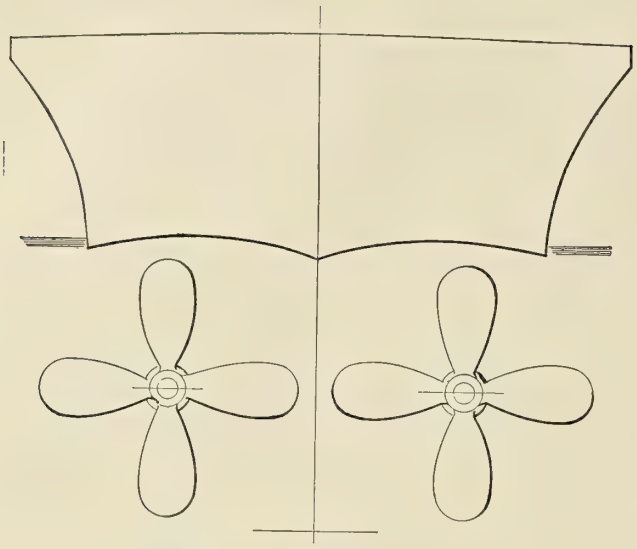
The hull is of mild steel throughout, built strong and rigid, especially in the stem where the overhang is great; the scantlings being equal to or in excess of the requirements of the United States standard register. The keel is of the flat plate type, 30 inches by 23 to 20 pounds, reduced at forward end only, and is efficiently connected to the stem and stern post. The stem is 7 by 2 inches, reduced to 5 by 2 inches, of cast steel, made in two pieces, with scarf at lower deck. It is rabbeted its entire length, and is shaped at the lower end to take the keel plate.

The stern post is cast steel, 7 by 4 inches for the forward post and 7 by 3½ inches for the after post, made in one casting, with all necessary gudgeons, tang and pads for struts. The rudder is hammered scrap iron 6½ inches diameter, while the stock is 5 inches diameter. The rudder is covered by two steel plates, with a pine wood filling between. The quadrant is steel, and keyed to the rudder below main deck.

The frames are 4 by 3-inch angles, spaced 30 inches aft, 24 inches in engine spaces, 30 inches in boiler space and 36 inches forward. Intermediate frames are fitted forward in way of the 36-inch spacing. Double frames are fitted on watertight bulkheads. The reverse frames are 3 by 2½-inch angles, single except in engine and boiler spaces, where they are double. The floors are single, tapered, 24 inches deep at center and deeper to take engine bed plate and to suit conditions in the stern. They are connected to the center keelson plate by double angle clips.

The center keelson is a 15-pound vertical plate, of extra depth in engine space to accommodate the engine bed plate. There are three keelsons on each side of the vessel, one intercostal of 11-pound plate in bottom and two on bilge and side, of 5 by 3-inch angle carried all fore and aft, and having breast hooks at the ends.

The main deck beams are structural channels, 7 by 2 by 2 inches on every frame; they are double on bulkheads, and are connected to the frames by 15-pound brackets. Structural channels were used because they could be obtained quicker from the mills. The lower deck beams are 5 by 3-inch angles,



SECTION SHOWING ARRANGEMENT AT STERN.

set with the long leg up. In the bosoms are laid the carlins on which the lower deck rests. There are eleven webs; three fitted in the after hold, on every other frame in the engine space and two in the forward hold, built of 15-pound plate and extending from the keel to main deck.

The longitudinal coal bunker bulkheads, built each side of the boiler room, are of 10-pound plates, well stiffened by angles. The starboard bulkhead is offset for a passageway which leads into the engine room.

The shell plating is of the raised and sunken type, the outside strakes being fitted with solid liners in way of frames. The bilge and sides are 16 pounds, reduced to 14 pounds at the ends, sheer strake 23 pounds, reduced to 20 pounds at the ends, and the knuckle is 23 pounds throughout. The deck stringers are 18 to 14 pounds; the ties are 18 inches wide, laid diagonally, and 6 inches laid fore and aft. The deck is plated solid over coal bunkers and engine space, and is laid with 5 by 3-inch white pine planking. The stringer bars are 2½ by 2½-inch by 5-pound angles.

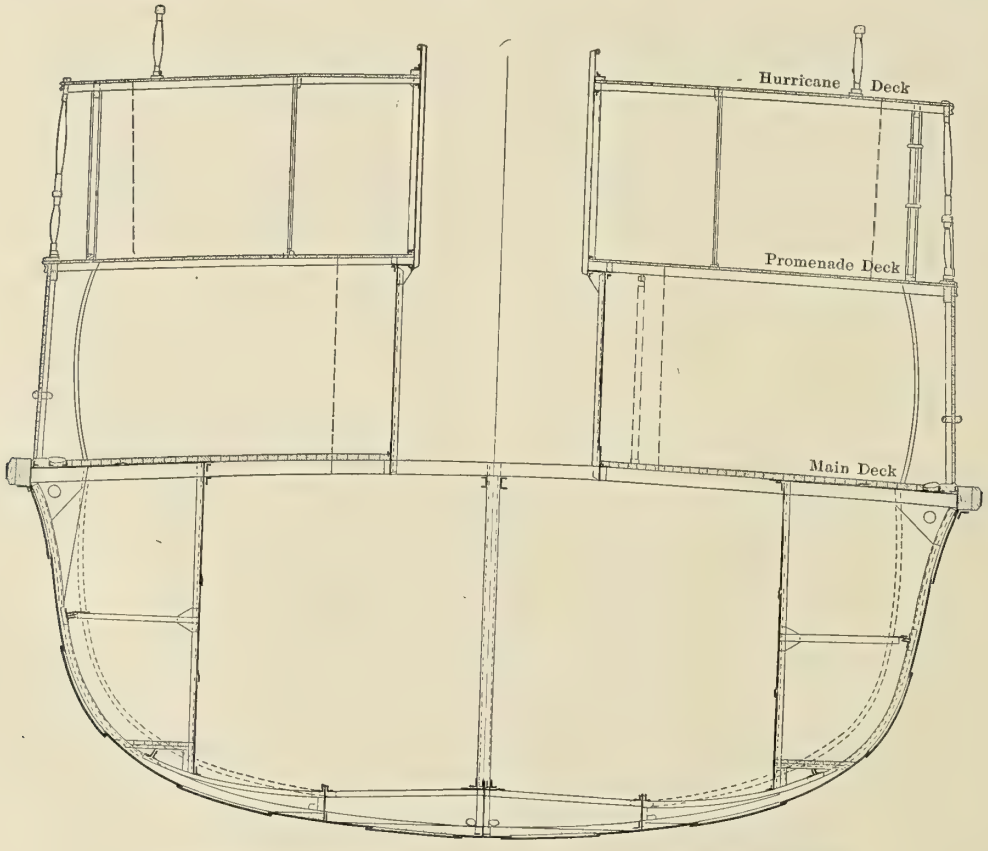
The deck machinery consists of a Hyde windlass, located on the main deck, with capstan on deck above; one kedge and two bower anchors, with all the necessary chains; a steam steering engine of the Williamson Bros. (Philadelphia) make, located in the hold aft, with leads to the wheel in the pilot house (a hand-steering gear is fitted aft on promenade deck); a Williamson elevator engine located on main deck to operate the elevators which lower the cargo into the hold.

The cabin is tastefully and conveniently arranged, finished in soft wood, painted and trimmed with gold leaf, except in the lobby, which is finished in mahogany. Several state rooms are provided for passengers on promenade deck.

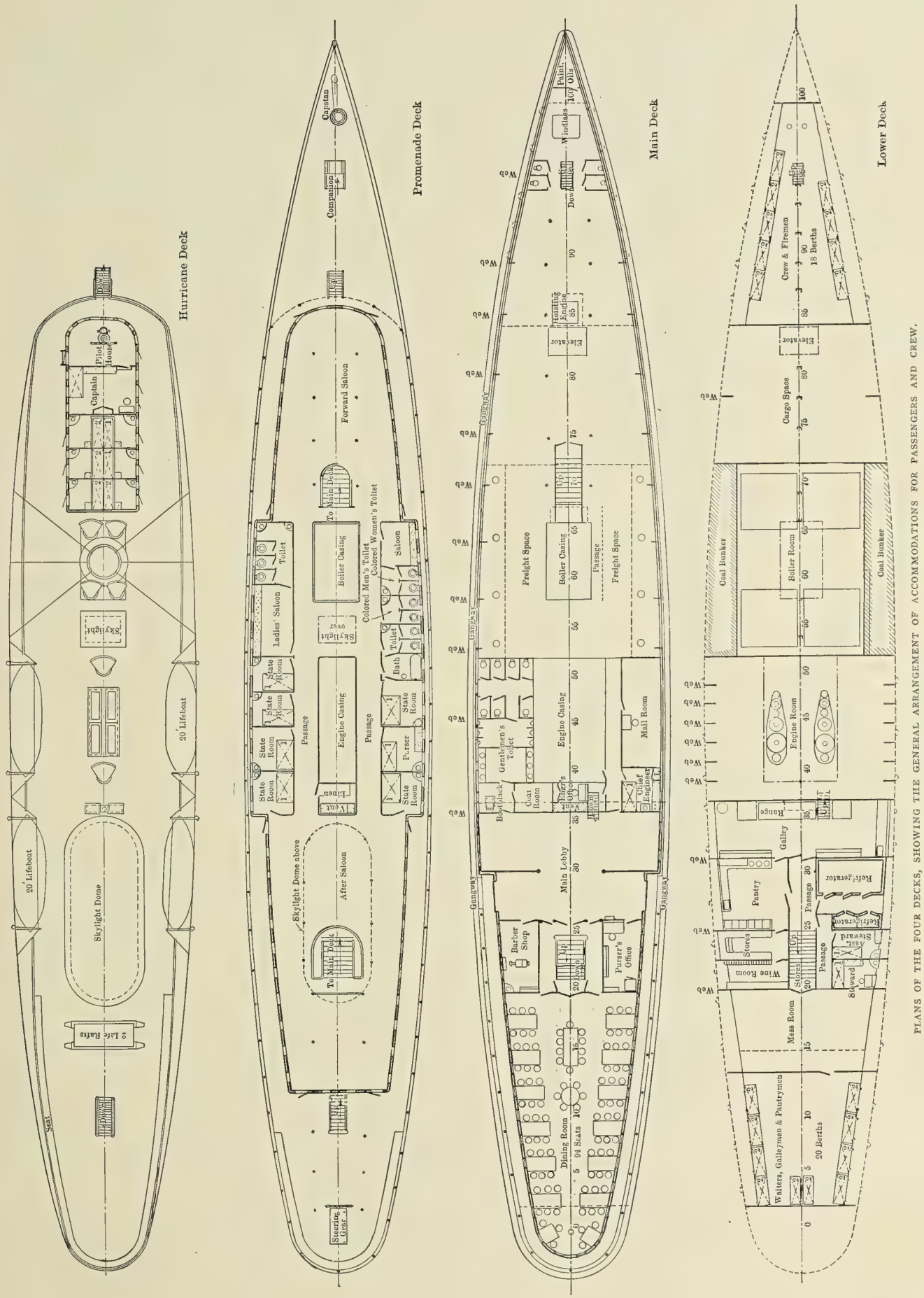
PROPELLING MACHINERY.

The *Maryland* is propelled by two fore-and-aft, three-cylinder, triple-expansion engines, having cylinders 17, 27½ and 44 inches in diameter, with a common stroke of 26 inches. The cylinders are supported in back by cast-iron box columns, and in front by three round wrought steel columns. The high pressure and intermediate cylinders are fitted with single-ported piston valves, and the low-pressure cylinders have double-ported piston valves. All cylinders are fitted with cast iron covers and corrugated steel false covers.

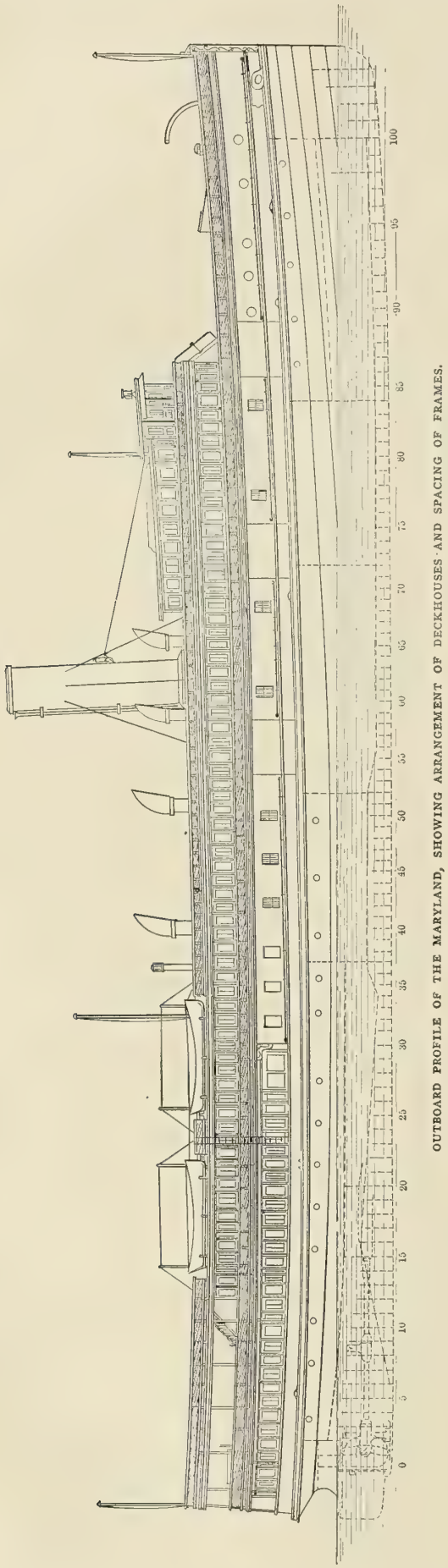
The pistons are of the cone type, with cast iron snap rings. The high-pressure and intermediate-pressure are of cast iron body; but the low-pressure has a cast steel body. All piston rod and valve stem stuffing-boxes are fitted with United States metallic packing. The Stephenson link motion is fitted, having steel eccentric and suspension rods and brass link blocks and boxes. The eccentric sheaves and straps are of cast iron. The reverse shaft, 4 inches diameter, is supported on the back



MIDSHIP SECTION OF THE MARYLAND, SHOWING GENERAL FORM AND ARRANGEMENT.



PLANS OF THE FOUR DECKS, SHOWING THE GENERAL ARRANGEMENT OF ACCOMMODATIONS FOR PASSENGERS AND CREW.



OUTBOARD PROFILE OF THE MARYLAND, SHOWING ARRANGEMENT OF DECKHOUSES AND SPACING OF FRAMES.

columns by cast iron brackets, and is operated by a steam cylinder 9 inches diameter by 15 inches stroke.

The connecting rods are wrought steel, of the forked type, 3¾ inches diameter at top end and 4½ inches at crank end. The cross-heads are forged steel, having pins 4½ inches diameter by 5½ inches long, fitted with composition boxes. The slippers are steel castings, lined with white metal. The cross-head guides are of the hollow cast iron bar type, having connection to sanitary pump for circulating water through them. The crank pin boxes are cast steel, lined with white metal and fitted with brass horseshoe liners. Both engines are fitted with complete lubricating and water service gears to all working parts.

The crank shaft is of the built-up type, 8⅜ inches diameter. The crank pins are 8½ inches diameter by 10 inches long. The thrust shafts are 8⅜ inches diameter, each having six collars forged on. The thrust blocks are of the horseshoe type, permitting independent or collective adjustment of collars. The collars are made of cast iron faced with white metal. All line shafts are 8⅛ inches diameter, supported at proper intervals by cast iron bearings, lined with white metal.

The stern tube and outboard shafts are 8⅝ inches diameter, covered by composition sleeves in way of shaft strut and entire length of the stern tubes. The stern tubes are cast iron with brass stuffing-boxes and bushings lined with lignum vitæ. The shaft struts, of which there are two on each side, also have brass bushings lined with lignum vitæ.

The propellers are of manganese bronze, 8 feet 8 inches diameter, of the solid four-blade type, secured to shaft by key and brass nut.

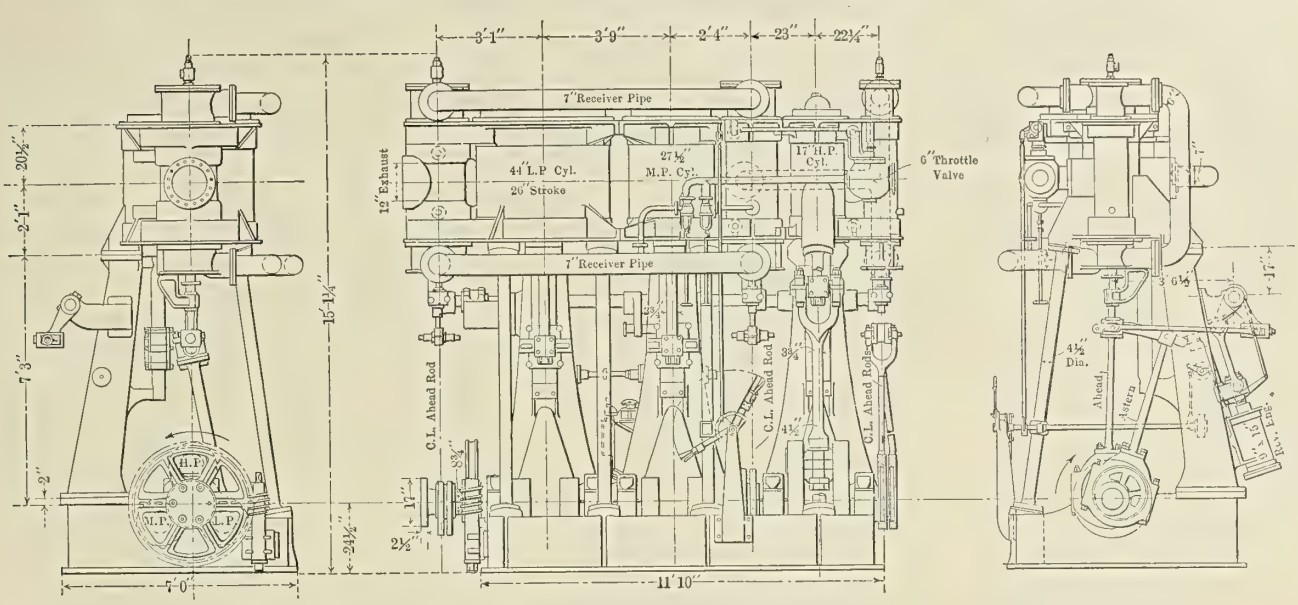
The boiler plant of the *Maryland* consists of four single-ended Scotch boilers, each 12 feet mean diameter by 11 feet 6 inches long, built to the United States inspection, to carry a working pressure of 180 pounds per square inch. Each boiler contains two Morison suspension furnaces 45 inches inside diameter, and one common combustion chamber. The plant has a total grate surface of 195 square feet, and a total heating surface of 7,325 square feet, the ratio being 37.5 to 1. All boilers are connected to one elliptical stack 6 feet 10 inches by 5 feet 10 inches, extending about 68 feet above the grate. The furnace fittings are of the usual type, consisting of cast iron grate bars, bridge walls and front and door liners, etc. The grate bars are in two lengths, the grate being 6 feet 6 inches long.

There is one steel plate shell condenser, 5 feet diameter, containing 2,245 ⅝-inch brass tubes. The tube plates are of steel. The packing consists of a sheet of pure rubber, through which the tubes extend. This rubber is held in place by a thin brass plate, secured by screws tapped into the tube sheet. The heads are of cast iron. The condenser contains 2,853.5 square feet of cooling surface, measured on the outside of the tubes.

All pumps are independent of the main engine, and consist of one vertical, twin beam air pump, cylinders 10 and 20 inches by 10-inch stroke; one vertical duplex feed pump, cylinders 10 and 7 inches by 10-inch stroke; two horizontal duplex sanitary and bilge pumps, cylinders 6 and 5¾ inches by 6-inch stroke; one horizontal duplex fresh water pump, cylinders 4½ and 3¾ inches by 4-inch stroke; one Morris Machine Company centrifugal circulating pump, 10-inch suction and discharge, driven by a vertical engine, 7 by 7 inches. A Reilly feed-water heater has also been provided by the Griscom-Spencer Company, New York.

A very complete electric light system has been installed, consisting of two General Electric Company's (Schenectady, N. Y.) dynamos and engines, one being of 4 kilowatts and one of 15 kilowatts capacity.

George Jenkins and A. E. Woodruff.



ONE OF THE TWO TRIPLE EXPANSION ENGINES OF THE MARYLAND: SIDE ELEVATION AND TWO END ELEVATIONS

A Shelter-Deck Cargo Steamer.

We present photographs of an interesting shelter-deck cargo steamer built by Mackie & Thomson, Glasgow, and launched from their yard for Leach & Company, Ltd., London. Of this steamer, *Sea Belle,* the principal dimensions are: Length between perpendiculars, 300 feet; breadth, extreme, 42 feet; depth molded to main deck, 21 feet; to shelter deck, 30 feet 6 inches, and gross tonnage, 2,100. The captain, officers and engineers are berthed in houses on the shelter deck amidships, and the crew in the forecastle under the shelter deck. The vessel has extra large hatches, eight steam winches, water ballast in cellular bottom all fore and aft, and extra large peak tanks, and six very deep 'tween decks for stowing bulky cargo.

Her machinery consists of a triple-expansion engine having cylinders 22, 36 and 59 inches in diameter by 39-inch stroke, supplied with steam by two cylindrical boilers 15 feet 9 inches diameter by 10 feet 9 inches long, working at a pressure of 180 pounds per square inch, and a donkey boiler 10 feet diameter by 10 feet long. The machinery is supplied and fitted on board by David Rowan & Company, Glasgow. The engines are of 1,500 indicated horsepower, and are expected to give the vessel a speed of 9½ knots.

An armor contract, covering 2,100 tons at a value of $1,000,000 (£205,000), is reported to have been obtained from the Italian government by the Midvale Steel Company, of Philadelphia, in competition with five European firms, including the famous Krupp establishment. The average price to the ton figures out at about $476 (£98), which is some $131 (£27) greater than the bid of $345 (£71) per ton made to the United States government for the armor to be placed upon the new battleships *South Carolina* and *Michigan.*

Subsequent to the placing of the above contract, the Italian armor-plate factory at Terni accepted a contract to provide the Italian navy with 6,000 tons of armor plate at the price quoted by the Midvale Steel Company. As the difference between the bids of these two companies on the first contract was $180,000 (£37,000), it will be seen that the Italian government has made a very substantial saving on the second contract.

TWO VIEWS OF THE SHELTER-DECK STEAMER SEA BELLE, BEFORE AND AFTER LAUNCHING.

A Family Gathering in a Boiler Shop.*

BY "SHIPYARD PICKLING."

Not many months ago there was gathered in a large boiler shop down near the water front a number of representatives of the marine branch of the well-known Boiler family. Reunions in this branch are, as every one well knows, very few and far between, as the members are all hard workers, and do so much traveling that it is seldom they have a chance to meet and commune with one another. On this particular occasion there happened to be, for one reason or another, a delegate from about all the important groups who follow the sea for a living. There was old man Scotch, who rejoices in having four furnaces, and a shell so thick that it could in time of necessity almost be used for a protective deck; near him squatted old Mother Waterleg, recently taken out of an East river ferryboat, and who, general gossip claimed, ought to have been hit in the head and drowned years ago. The watertube members were there in plenty, prominent among them being Mr. B. & W., Monsieur Niclausse, "John" Thornycroft, "Yank" Roberts, "Bill" Almy, "J. Bull" Yarrow, "Gus" Mosher, "Doc" Ward and several smaller members. Scattered about in the gathering were "Johnny" Gunboat, "Marine" Locomotive, who seemed rather ill at ease, and away over in the corner, aloof from the rest of the crowd, was "Pop" Doghouse, leaning on his last legs.

At first the conversation was general, various inquiries being made about the health of absent members, and in an exchange of reminiscences of events since the last meeting old man Scotch's voice could be heard above the general buzz of conversation, as he grunted out his opinion of things in general. The fact is, the old man was what might be termed "chesty," due, no doubt, to the fact that the members of his particular family were more numerous than any of the others. His dislike for the watertube branch was quite pronounced, and he never lost an opportunity to sneer at them, and say something sarcastic about the "bundles of gas pipe," as he termed them. B. & W., being the largest of his family, would occasionally fly up and resent some of Scotch's insinuations and insults, and could almost always get a "rise" out of the old boy by calling him a "good old has-been" or a "hard shell Baptist, full of water." Niclausse couldn't speak very good English, but would invariably back up B. & W. by shouts of "Oui! Oui!" until his inner tubes would vibrate. "John" Thornycroft and "J. Bull" Yarrow would yawn their furnace doors open and say, "Oh! what a beastly bore the old chap is, doncherknow."

During a lull in the conversation old Mother Waterleg piped out in her low-pressure voice, "Well, what do all you good boiler people think about the gasoline engine?" Instantly there was a chorus of hisses, as if every boiler present had blown out a tube. "I'm agin' 'em," growled out Scotch; "they are putting too many of our young relatives out of business. If they keep on the way they have been doing it will be mighty hard for our half-grown children to earn a living in these launches and yachts.'

"Oh! come off, Scotch," shouted "Yank" Roberts, "Doc" Ward and "Bill" Almy, in chorus; "what good are *your* half-grown children in a launch or yacht anyhow?" "That's all right," retorted Scotch; "so that's all the credit you give me for standing up for you. Well! what would a boiler jawfest be, anyhow, if some one didn't get out a hammer?"

Aside from this slight interruption it was quite evident that all present were sore on the gasoline engine proposition, and much in the attitude of the Irish orator in New York, who "viewed with alarum the growth of the Girman ilement."

Like their human prototypes, the more garrulous of the boilers began talking of the health of themselves and their friends. Nearly all had some disease or ailment of which to complain. Old man Scotch had a few leaky rivets, dropsy in one of his crown sheets, and complained of a dullness in his heating surfaces. Some of the watertube brethren complained of sagging tubes, leaky joints and pitting in their steam drums. All agreed that their human doctors failed to give them proper medical attention.

Old Mother Waterleg nearly precipitated another outburst of anger among the crowd, by gravely asking them if they did not think they were entitled to as much care and attention as was given to the engines for which they furnished the steam. Unwittingly she had touched upon a very sore subject, as nearly every well-trained boiler thinks that his lot is a hard one compared with his more fortunate brethren of the Engine family.

"The very idea," gasped "B. & W.," "of our doing all the work on board a ship, and the engines getting all the petting and attention from these engineers. Why, every time they stop that old Triple who goes in the same ship with me, they must needs rub him down and then go around and adjust all his parts as carefully as if he were a gold watch. All they do to me is to haul my fires up in a heap, throw a lot of old ashes over them, and let me look out for myself. The only sickness I ever feel is when they fill me up with some nasty old oil which that engine has had to mix in with the steam I give him to keep his rickety old cylinders from grunting. Once in a while when we are running they will condescend to blow the soot off my tubes, but they go at it so slowly that I get a chill from having my cleaning doors opened so long. The first thing they know I'll get a good bilious attack from having been fed too much grease, then I think they will pay me a little more attention. Only the other day I had an attack of acidity in my stomach, but that Second Assistant on our ship was kind enough to give me a dose of soda. He's a pretty good sort of chap, and if the old man would only let him have his way I know he would take very good care of me."

Old man Scotch gave his approval to those remarks, and said, in furtherance of the ideas advanced by his watertube brother, "If those human masters of ours would only treat us with half the consideration they have for workmen of their own kind, they would find it to be the best investment they ever made. We need to be properly clothed, fed and doctored just as much as men are, and while we can't speak their language, we certainly have a few grunts and hisses that we make use of when we are not properly treated. After all, our diseases are very similar. A man is exposed to the cold and dampness and gets lung trouble or other wasting disease; expose us to the cold and dampness and we split our plates or begin to rust away; if a man is fed on too greasy food he gets bilious and can't do his work; stick a lot of oil or grease into our feed-water and we get bilious and sluggish in our heating surfaces, and can't do half our usual work.

"When a human boiler gets overfed the man starts to smoke, gets dopy and wants to go to sleep; with us, if they fill our furnaces up to the crown sheets with fuel we will do exactly the same things. Of course, when we get in that condition, we are prodded up with long, disagreeable slice bars. I think some of those lazy mortals would get a move on them if they were prodded a little with a slice bar. When a man gets a pain he begins to weep, and others of his kind sympathize with him. How different with us poor devils; if we happen to get a pain in our plates and begin to weep at the seams they dig us in the vitals with one of those boot-legged calking tools, and if we don't stop right off they slap on one of those nasty soft patches, which is ten times worse than a mustard plaster. There's just one disease where mankind gets it just as bad as we do. The human pill doctor calls it smallpox; our doctors call it galvanic action when it attacks us;

* By courtesy The Bird-Archer Company.

but whatever it is we both have to carry the 'pock-marks' or 'pittings' or whatever you choose to call it, down to our graves. I understand that some wise guy among the two-legged gentry studied up on this smallpox disease and found some kind of stuff they call vaccine virus, which will prevent the thing from attacking any one who has been vaccinated with it. Now, if some one would just get busy and invent some kind of dope which would keep us from being pitted, we would all be happy."

"Hear! Hear!" shouted the whole metallic family. "Now you are talking sense, Old Man."

It was getting late, and "Thornycroft" and "Yarrow" began to show evidences of getting tired; "Almy" and "Roberts" actually yawned, whereupon Old Scotch chided them for disrespect to him during his lecture.

"Say, fellows," chimed in young "Mosher," "I've got a conundrum for you. Why is this old 'Papa' lecturer, when he is being treated for acid in his stomach, like a high-ball?"

"Give it up," said one after another.

"Oh! it's easy," sarcastically remarked Mosher; "it's simply because he is a combination of Scotch and soda!"

Even old Frenchy Niclausse snorted out his rage at such a horrible pun, and presently peace reigned over the shop, as every one had gone to sleep.

The German cruiser *Stettin*, of 3,350 tons displacement, has made a trial trip record of 25.8 knots for a short spurt. She carries ten 4.1-inch and eight 6-pounder guns, and two torpedo tubes.

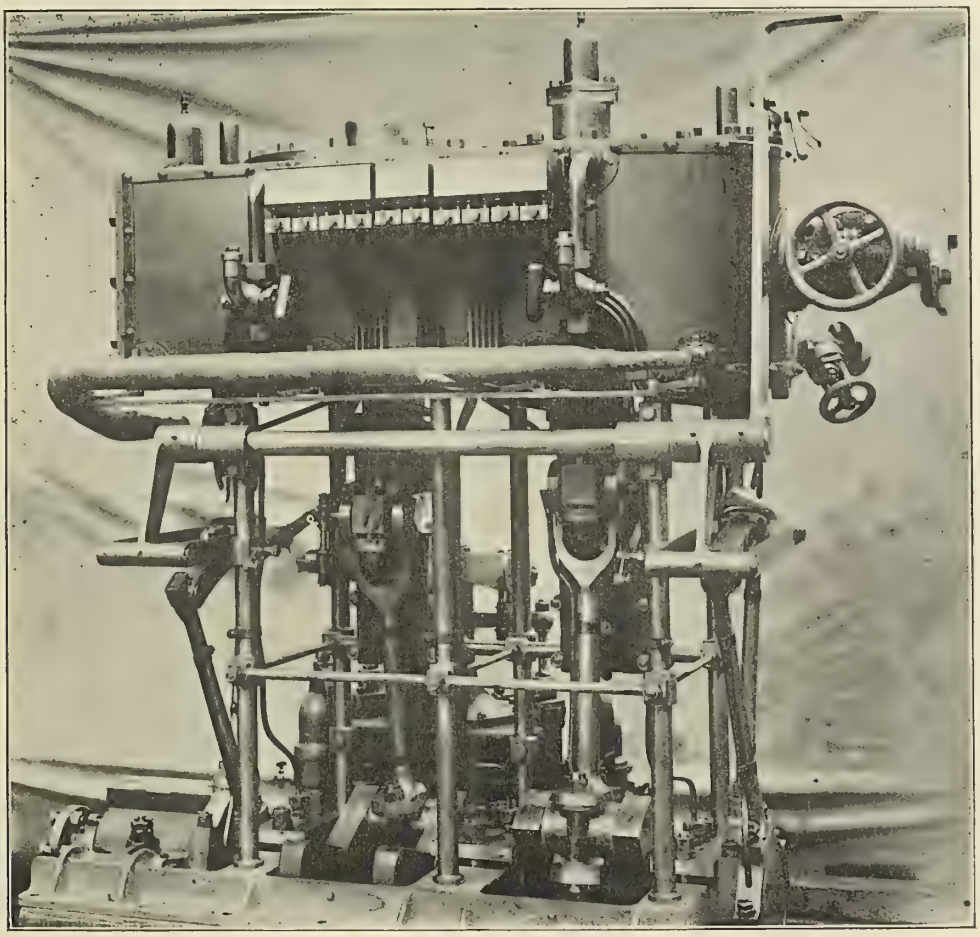
Japanese Steamship Clearances.

Tremendous increases are shown in the clearances of steamers from Japan for foreign ports. The figures given below represent in each case six months, ending June 30, for the years 1904, 1905 and 1906. They speak for themselves:

	Ships.	Tonnage.	Average.	Per-cent.
1904 First six months.....	3,661	5,631,886	1,538	....
1905, First six months.....	5,148	6,921,676	1,345	22.9*
1906, First six months.....	6,110	8,962,666	1,467	29.5*
1906, Japanese	3,691	2,834,415	768	31.6†
1906, British	1,078	2,997,000	2,780	33.4†
1906, American	281	1,152,215	4,100	12.8†

*Gain on previous year. †Of total tonnage cleared.

The high average tonnage of American ships is due largely to the fact that the *Minnesota* and *Dakota* (the latter now lost), of 20,718 tons each, were frequent visitors to the port of Yokohama. These were much the largest ships operating on the Pacific.



COMPOUND ENGINE OF SHALLOW DRAFT LAUNCH FOR USE IN INDIA.

A Tunnel Screw English Steam Launch for India.

A most interesting and unique tunnel screw steam launch has been constructed at Chiswick and packed in three sections to be re-erected by native labor in India, the various parts being properly marked to facilitate this work. One illustration shows this launch as tested on the Thames river, before it was dismantled and packed for export to Madras, for the use of the Madras Forest Department.

SHALLOW DRAFT TUNNEL SCREW STEAM LAUNCH FOR USE IN THE MADRAS PRESIDENCY, INDIA.

The boat at its trials made a speed of 13 statute miles per hour when burning wood as a fuel. It has a length of 67 feet, a beam of 9 feet 8 inches, and a draft of only 1 foot 6 inches, when in working order. There are two screws on the same shaft, arranged in a tunnel, this obviating all liability to damage when in service. This unique launch was designed by Sir Alexander Rendel, and constructed by Messrs. John I. Thornycroft & Co., Ltd.

The engine is of the vertical inverted direct double acting compound design, constructed at the Southampton Works. The speed is 400 revolutions per minute with a working pressure of 130 pounds per square inch, the engine developing 100 indicated horsepower. The stroke is 8½ inches, and the high and low-pressure cylinders measure 6¾ inches and 13½ inches in diameter, respectively. The boiler is of the marine locomotive type, with a heating surface of 130 square feet and a grate area of 15 square feet. As noted in the illustration, the engine is located just aft of the boiler, with no other protection than an awning, which extends the entire length of the boat.

NEW SWISS LAKE STEAMERS.*

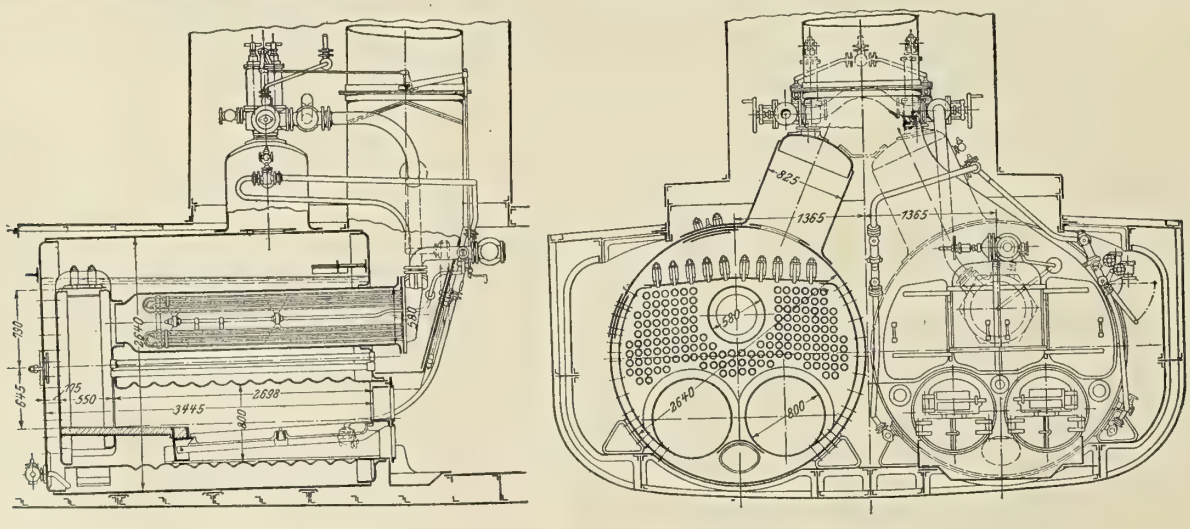
For service on Swiss lakes a number of steamers are used in connection with the tourist resorts. Two of the latest of these steamers are the *Blümlisalp* and the *Rhein,* built by Escher, Wyss & Company, of Zürich. These two steamers are very similar in general arrangement but differ somewhat in details, the *Blümlisalp* having a full cabin aft while the *Rhein* is fitted with only a partial cabin. The *Blümlisalp* is intended for the Lake of Thun and the *Rhein* for the Lake of Constance, and both were ready for service this summer. Their principal dimensions are as follows:

	Blümlisalp.		*Rhein.*	
	meters.	feet.	meters.	feet.
Length on deck	60	197	..	
Length between perpendiculars	58	190.4	54	177.3
Breadth of hull	6.8	22.3	6.6	21.7
Breadth over guards	12.8	42	..	
Depth	2.75	9	2.7	8.9
Displacement without passengers	283 tons		268 tons	
Passenger capacity	800		750	

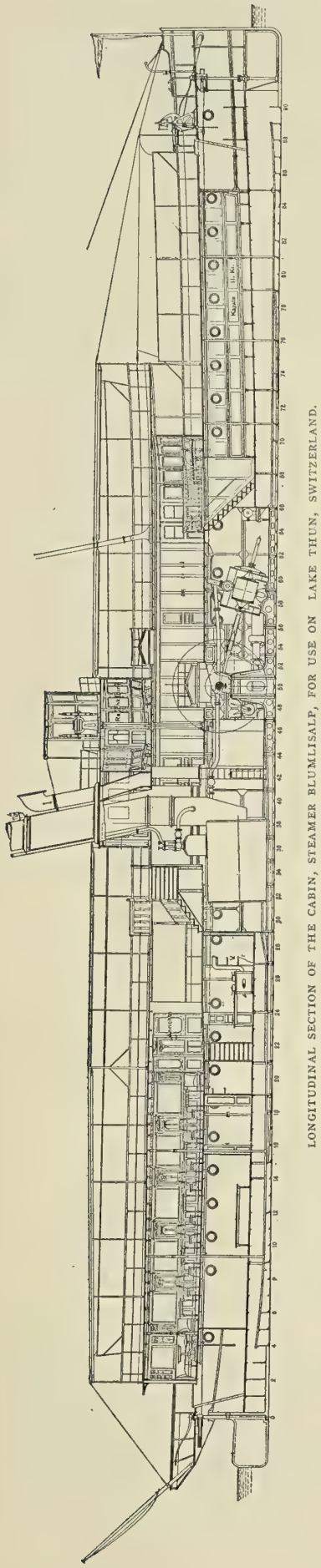
The illustrations show that the *Blümlisalp* is of shallow draft, with a cabin covering about two-thirds of the length. On the upper deck the entire space is open except for a small deck house inclosing the base of the funnel, and including a smoking room at the forward end. Above this is the pilot house. The only other obstructions on this deck are the gangway leading below, a skylight and the mast. The latter is forward of the smoking room and is hinged. Nearly all of the open space is occupied by benches, some of which have tables arranged alongside of them.

The main deck forward is fitted with benches and tables, except at the extreme bow, where the space is left clear for working lines and anchors. The second-class accommodations are in this part of the vessel, and in the forward part of the main deck house. The after part of this house is occupied

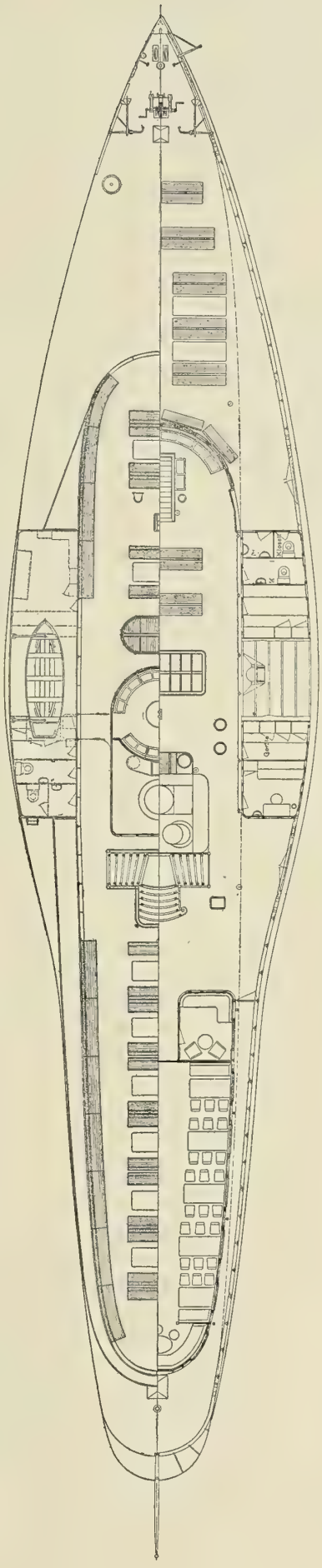
*Zeitschrift des Vereines deutscher Ingenieure.



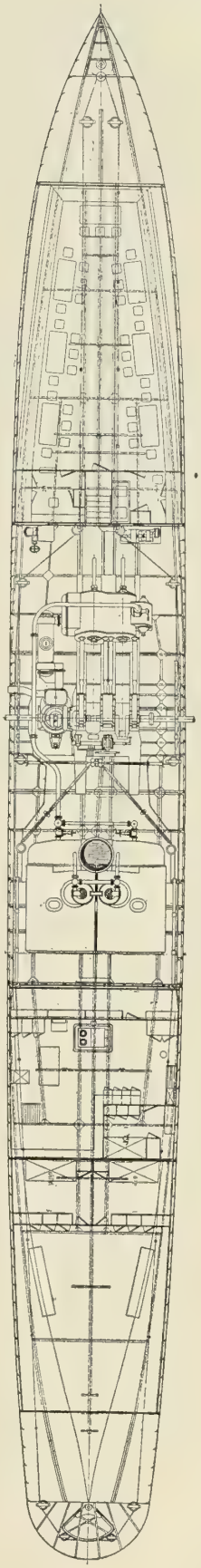
THE BOILER LAYOUT OF THE STEAMER. DIMENSIONS ARE IN MILLIMETERS.



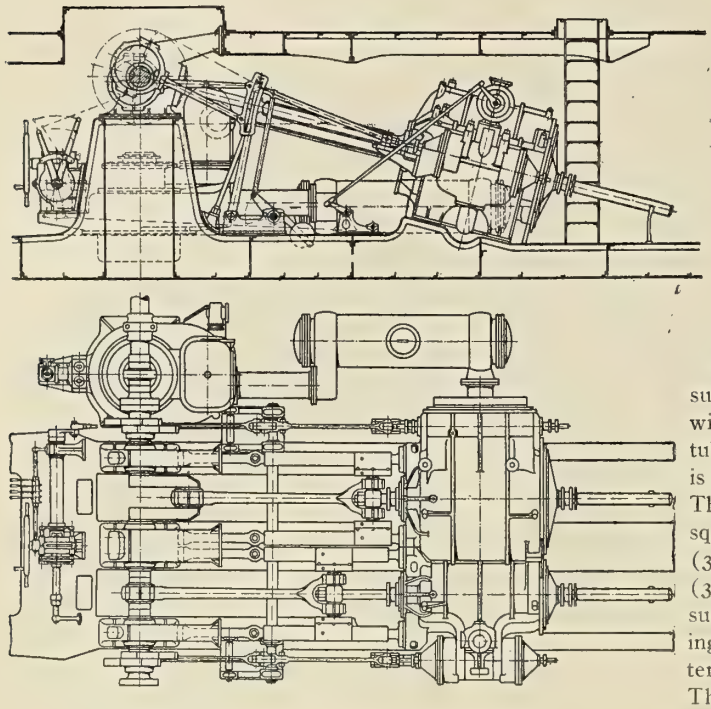
LONGITUDINAL SECTION OF THE CABIN, STEAMER BLUMLISALP, FOR USE ON LAKE THUN, SWITZERLAND.



HALF PLANS OF THE UPPER DECK AND THE MAIN DECK, SHOWING PASSENGER ACCOMMODATIONS.



THE LOWER DECK IS LARGELY ABSORBED BY THE MACHINERY REQUIREMENTS FOR PROPULSION.



LONGITUDINAL SECTION AND PLAN OF THE ENGINE.

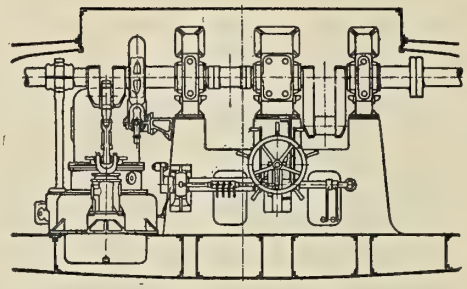
by a dining saloon for first class passengers. The small after deck is left clear for maneuvering. The wings in wake of paddle space are taken up by various officers' state rooms, and toilet rooms.

The lower deck has forward of the engine space a second class dining saloon. The paddle wheels are a little forward of the center of the length, while the engines, which are of the compound inclined type, are forward of the wheels. Aft of the boiler room come the galleys, while the stern is taken up by quarters for the crew.

In common with all the vessels on these lakes, this steamer has two rudders, one of them being forward. This is used whenever the vessel has occasion to run backwards, and is built inside the stem, to preserve it from danger of injury. Both rudders are long in the horizontal direction. Five watertight bulkheads of Siemens-Martin steel divide the hull into six separate compartments, which are further subdivided by wooden bulkheads.

The main engine has two cylinders with diameters respectively of 670 and 1,150 millimeters (26¼ and 45¼ inches) and a stroke of 1,150 millimeters (45¼ inches). They are supplied with superheated steam of a pressure of 10 atmospheres (147 pounds gage per square inch). On the low-pressure side of the engine is located the condenser with the air pump, which serves also on occasion as a drainage pump. Here are also located two feed pumps and the feed-water heater, which has a heating surface of 18.36 square meters (198 square feet). The feed water pumps are so fitted that they can be operated by hand if necessary. Two other pumps in the engine room are used for various purposes, including deck washing, the maintenance of a water supply in various parts of the vessel, etc. They may also be used for fire purposes or for feeding the boilers. An ejector is fitted in the bilges of each watertight compartment.

The paddle wheels have a diameter of 3.9 meters (12 feet 10 inches). Each wheel has nine paddles of a length of 2.6 meters (8 feet 6 inches), and a breadth of 720 millimeters (28¼ inches), made of a plate of iron. The eccentrics for feathering the paddles are made of cast steel. The rest of the paddle wheel parts are made of a good quality of malleable iron.



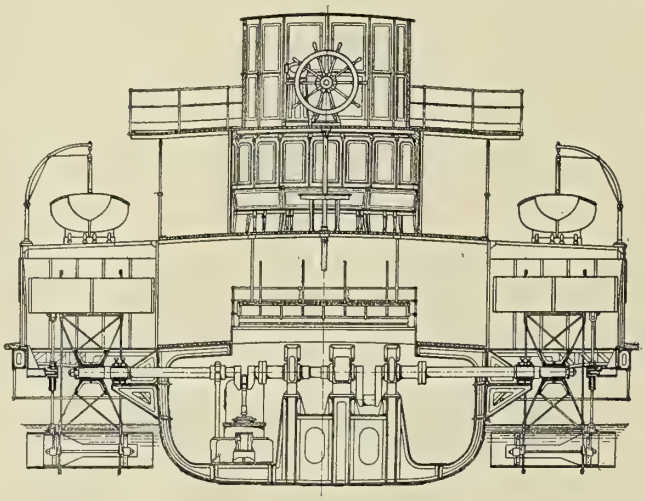
TRANSVERSE SECTION OF THE ENGINE SPACE.

Steam is furnished by two cylindrical boilers fitted with superheaters of the Schmidt type. Each boiler is provided with two furnaces, 154 evaporation tubes, and 60 superheating tubes, and is surmounted by a steam dome. The boiler shell is in each case made of a single plate with triple riveted joint. The heating surface measures 118.9 square meters (1,280 square feet), the superheating surface, 28.4 square meters (305 square feet) and the grate surface 2.88 square meters (31 square feet). The ratio of direct heating surface to grate surface is 41.3 to 1; while the ratio, including the superheating surface, is 51.1 to 1. The 154 tubes have external and internal diameters of 76 and 69.5 millimeters (3 and 2¾ inches). The 60 superheating tubes have an external diameter of 28 millimeters (1.1 inches), and an internal diameter of 20 millimeters (0.787 inch). The steam space has a capacity of 2.5 cubic meters (88 cubic feet).

The superheating tubes are placed within a flue contained within the boiler, and measuring 580 millimeters (22¾ inches) in diameter. This flue forms a portion of the water heating surface, as a portion of the furnace gases passes through it on their way to the uptake, performing the duty of superheating the steam while in passage. The flue lies in the midst of the upper rows of heating tubes. The two Morison suspension furnaces have each an internal diameter of 800 millimeters (31½ inches). The diameter of the boiler is 2.64 meters (8 feet 8 inches), and its length is 3.445 meters (11 feet 3 inches). The steam domes are 825 millimeters (32½ inches) in diameter.

A dynamo in the engine room is installed for electric lighting. It is operated by a 10-horsepower De Laval steam turbine, and furnishes current at 110 volts. There are altogether 90 incandescent lamps and two are lamps.

The *Blümlisalp* made on trial trip 620 horsepower, giving a mean speed of 26.15 kilometers (16.27 miles) per hour, or 14.1 knots. The coal consumption was 455 kilograms per



SECTION AT FRAME 46, AMIDSHIPS.

hour, which figures out at 1.62 pounds per horsepower-hour. Under forced draft a speed of 29.2 kilometers (18.15 miles) per hour, or 15.7 knots, was reached.

The *St. Gallen,* a sister ship of the *Rhein,* with a load of 5 tons of coal on board and complete equipment, and having a mean draft of 1.27 meters (4 feet 2 inches), made a mean speed between Bregenz on Lake Constance and Ludwigshafen on the Rhein, a distance by lake and river of about 275 miles, of 26.82 kilometers (16.67 miles) per hour, or 14.45 knots, with a coal consumption of 482 kilograms (1,062 pounds) per hour, and the engines developing 633 indicated horsepower. The coal consumption was here 1.68 pounds per horsepower-hour.

THE STEAMER RIO YGUAZU, BUILT BY THOMAS DOBSON & COMPANY, HULL.

An Argentine River Steamer.

The twin screw steamer *Rio Yguazu,* which has made a trial trip on the Humber, has been constructed by Thomas Dobson & Company, of Hessle, Hull, her dimensions being 155 by 27 feet by 7 feet 6 inches, with two sets of compound engines, having cylinders 15 and 30 inches in diameter by 20 inches stroke. For the expeditious discharging and working of the vessel there are two steam cranes, a steam winch, steam windlass and steam steering gear.

The vessel is for passenger and cargo trade on the River Plata, and is fitted with accommodation for 80 first-class passengers in the large deck house and a large number of second-class passengers on the main deck. The saloon and the staterooms are all painted and enameled white, and the furniture is of light polished oak. On the upper deck there is a music room, fitted with a piano, etc. The whole of the accommodation is well ventilated and fitted with numerous electric fans. The upper deck is covered with canvas, and forms a roomy promenade for the passengers, protected by an awning fore and aft. There is a very complete installment of electric light and all other conveniences required in high-class passenger boats.

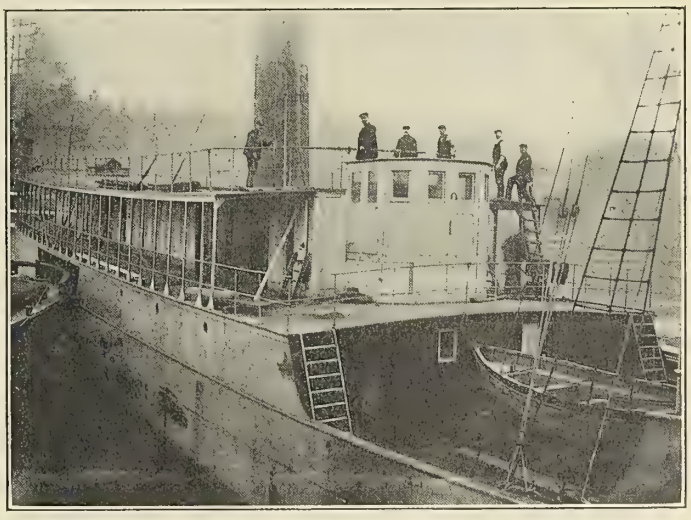
During the trial trip, four runs were made on the two-mile marked course on the river Humber, the result being an average speed of 10¼ knots, this being in excess of the contract speed of 10 knots. The engines worked admirably, and were tested in all respects, there being no heating of bearings or other trouble. The turning test of the vessel, by running one engine ahead and the other astern, resulted in the vessel's being practically turned in her own length, which will be of considerable advantage on the River Plata.

James Fisher.

A Sixty-foot Motor Passenger Boat.

The *Doris* is a passenger-carrying boat, built by J. W. Brooke & Company, Limited, Lowestoft, for river use. The boat is 60 feet long, and has a draft of only 2 feet 6 inches. She is built of oak and elm, and has a Board of Trade certificate for carrying sixty passengers. Under the small deck forward is the ladies' cabin, while aft is the main saloon; between the two is a promenade deck, covered by a fixed awning, and in the stern is another open deck. The main saloon is fitted with cupboards and a bar, while the boat is navigated from a steering position just above the forward end of the saloon, the helmsman looking over the awning.

The engine, which is a four-cylinder marine motor of 18 horsepower, is installed under the promenade deck aft, and gives the boat a speed of seven miles per hour. It is operated entirely from the steering wheel, even to the question of lubrication, so that after once starting, the entire control of the boat is vested in the helmsman. The boat has been running for some time, and is said to have given her owners splendid satisfaction.



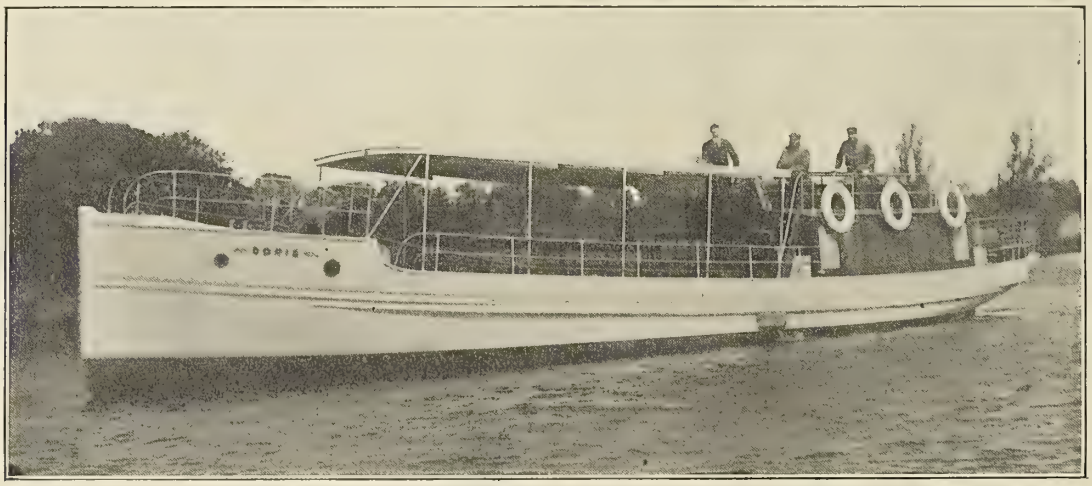
THE UPPER DECK OF STEAMER RIO YGUAZU.

The engine has a cast iron inclosed crank chamber, and weighs 450 pounds. It operates a propeller 19 inches in diameter, the tail shaft having a diameter of 1 9/16 inches. The stern tube, which is 22 inches long, has a diameter of 2⅜ inches. The fuel consumption of the engine is about

1⅓ gallons per hour, or about 0.6 pint per horsepower per hour. The cylinders are cast in pairs, and the valves are all mechanically operated, on opposite sides of the cylinders. An instrument board is provided on the after side of the motor, on which are grouped all the controlling levers and the lubricator. Standard high-tension magneto ignition is fitted, but high-tension electric ignition can readily be substituted. The circulating pump is self-contained with the motor, and is of the eccentric control type. The engine is governed on the throttle by a centrifugal governor. A metal-to-metal clutch is provided in the flywheel, operated by a foot pedal.

The engine has the following dimensions:

Length over all, including thrust block at one end and starting handle at the other	5 feet 7 inches
Net length of engine proper, including flywheel	2 feet 8 inches
Extreme width	23 inches
Height of top of cylinders above center of shaft	16½ inches
Diameter of flywheel	16¼ inches



THE PASSENGER BOAT DORIS, BUILT BY J. W. BROOKE & COMPANY, LIMITED.

Motor Boat Propellers.*

BY GEORGE R. MC DERMOTT.

When a boat is propelled at a uniform velocity, two sets of forces are brought into action—(1) forces acting between the hull and the water through which it is moving—(2) forces developed by the action of the propeller on the water in which it is working; in both cases, however, only the forces which act parallel to the line of advance are taken into account. The resultant force acting between the boat and the water, as also the air, is familiarly known as the resistance R, while that developed by the action of the propeller on the water constitutes a thrust T. It is self-evident that when the boat has acquired uniform motion, the two forces, R and T, must be equal and opposite. The thrust is obtained from reaction, and is measured by the momentum imparted to the mass, forming the column of water projected astern by the action of the propeller, with a velocity s; this sternward velocity or acceleration is generally referred to as the "slip."

Let W = Weight of water (in pounds) acted upon by the propeller per second,

v = Speed of advance (feet per second) of the propeller relative to still water,

s = The "slip" or sternward velocity (feet per second) imparted to the column of water, relative to still water.

Then—

Thrust ..... $T = \frac{Ws}{g} = R$

Useful work, done on the boat ..... $Rv = \frac{Wsv}{g} = Tv$

Kinetic energy imparted to the water by the propeller ..... $= \frac{Ws^2}{2g}$

Total work ..... $= \frac{Wsv}{g} + \frac{Ws^2}{2g} = \frac{Ws}{g}(v + \frac{s}{2})$

Efficiency ..... $= \frac{\text{useful work}}{\text{total work}} = \frac{\frac{Wsv}{g}}{\frac{Ws}{g}(v + \frac{s}{2})} = \frac{v}{(v + \frac{s}{2})}$

While the above equations, as applied to screw propellers, present an inadequate treatment, in that no account is taken of the energy wasted in friction, in the reactions in other directions than that of the line of advance (due to the obliquity of the propeller blades), and in eddying and other disturbance of the water caused by the propeller; nevertheless, they are of great value, as indicating the fundamental principles by which the action of all forms of propelling agents are governed. As in other branches of applied science, these theoretical expressions have to be supplemented by empirical factors and coefficients, obtained in the field of experiment, which represent relations and effects that are beyond the reach of the analyses and deductions of pure theory. Even if it were possible to establish a complete theory of the action of the isolated screw propeller, it is to be remembered that, when associated with a ship or boat, it would be working under a modified set of conditions, due to the disturbing effects of the hull on the water, constituting the "feed" to the propeller. This may be better appreciated by pointing out that, in its passage through the water, the hull exerts a retarding influence (from frictional and other causes) on the particles of water with which it is immediately in contact. These in turn communicate this influence to other particles with which they are in contact, with the

* *The Sibley Journal of Engineering.*

result that the water which enters the propeller field has suffered a certain degradation of velocity in its journey aft. This reduction of velocity varies in amount with the length, form and proportions of the boat, so that, while in a given case the speed of advance of the boat and propeller, relative to still water, would be (say) 20 knots, the speed of advance of the propeller, relative to the water in which it was working, and which had been affected by the hull, might be only 15 knots; the difference between the two speeds being termed the speed of the "wake."

The fundamental equations presented show very clearly that the whole propeller problem consists simply of determining whether in a given case it would be better to impart a high velocity to a small mass, or a low velocity to a large mass of water, in the production of a required thrust; *i. e.,* a small propeller working with a large slip, or a large propeller working with a small slip, while fulfilling the conditions that might be imposed by limitations of draft or the rotational speed of the type of motor selected, the other characteristics of the propeller—number, shape and thickness of blades—being such as to obtain the best efficiency possible.

Reference has been made to the necessity of obtaining, for use in the final equations for practical application, factors or coefficients derived from experiments. These have been obtained from exhaustive experiments made on model propellers by Froude in England, Denny in Scotland, Rota of Italy, and Taylor, chief of the U. S. Experimental Basin. These are named in the order of the dates of the experiments, and while the results obtained by these four experimenters differ in some of the minor details, they are otherwise in substantial agreement.

From these results practical working formulas have been derived, by the use of which we are able to determine the dimensions and proportions of screw propellers for all types of vessels and conditions of use. The possibility of using the results derived from experiments on models, in designing actual sized propellers, lies in the application of the "laws of kinetic similitude." The legitimacy of this, as applied to propellers, has been amply verified by special and independent experiment. The writer may add that a personal use, during a period of over twenty years, of the results obtained from model experiments on both ships and propellers, in the designing of vessels actually built, has almost invariably given the anticipated results well within the degree of accuracy allowable in engineering practice.

It is not within the scope of this article to give the details of the experiments referred to, or of the analysis of the results, by which the formulas for determining the dimensions and proportions of propellers have been obtained. The formulas as presented, while of the same general character as those suitable for general application, have been specially framed for use in the motor boat field. The coefficients have been specially dealt with, so as to include the effect of "wake" and other inter-reactions between the boat and the propeller, the mechanical efficiency of the motor, and the conditions of service which are peculiar to the boat and her machinery, so that they can be directly applied to the problems in hand. There are certain characteristics of the propeller which have, however, to be predetermined. These we will now discuss, adding such advice as experiment and observation have indicated as belonging to the best practice. This discussion is accompanied with such definitions as has been deemed necessary, for those who may have a more or less incomplete knowledge of the terms and notation peculiar to the marine construction branch of engineering.

Diameter.—This is the diameter of the circle described by the tips of the blades. It may be, and in motor boats generally is, restricted on account of draft limitations. Care should be taken in seeing to it that the tips of the blades should be a few inches above the line of keel, and below the surface of the water, when lying at rest, at least 10 to 15 percent of the draft.

Pitch.—The pitch, at a given point of the driving face, is the distance that this point would travel, in direction of the axis of the shaft in one revolution, provided that the propeller was working in a solid fixed nut. The pitch of the blades may be made to vary, either radially or axially, but experiment has shown that nothing is gained by departing from a uniform pitch. The pitch ratio is the ratio of the pitch to the diameter.

Slip and Slip Ratio.—If P = pitch in feet; R = revolutions per minute; V = speed of boat in feet per minute; and V_1 = speed of water in which the propeller is working, then the apparent slip will equal $P \times R - V$, and the true slip will equal $P \times R - V_1$. As the pitch ratio is one of the quantities determined by use of the formulas, the value of the slip follows. The slip is frequently referred to as a ratio, or percentage; thus slip ratio

$$= \frac{P \times R - V}{P \times R}$$

Number of Blades.—Either three or four blades may be used, as experiment has shown an equal efficiency. Three-bladed propellers are more commonly used in motor boats, probably on account of being cheaper than four-bladed. Where it is necessary to employ a large surface, leading to inordinate width of blade—say four-tenths of the diameter—then four blades may be used with advantage.

Shape of Blades.—Experiments have proven, most conclusively, that the most efficient shape of blade is that of a true ellipse.

Shape of Section of Blade.—Experiments on the shape of section are not conclusive, but, so far as present indications go, the segment of a circle is as good as any other, the driving face of the blades being flat. The thickness of the blades should be made as small as possible, consistent with strength.

Surface.—The surface of a propeller is the area of the helicoidal or expanded surface of all the blades. Occasionally the projected surface is referred to (projected on a transverse plane), but in design this is of little use. The surface is most conveniently dealt with as a ratio to the disk area, *i. e.,* to the area of the circle swept by the tips of the blades. In motor boat practice, the surface ratio varies from about 0.3 to 0.36 in three, and from 0.36 to 0.48 or 0.5 in four-bladed propellers; 0.36 has been assumed in framing the formulas. Where diameter is limited, or revolutions of motor large, the larger values of surface ratio should be used.

Raking of Blades.—It has been found by experiment that raking the blades, either forward or aft, is of no advantage, except in the case of vessels having very full after bodies, but this is not a condition likely to be encountered in motor boat work.

Efficiencies.—The efficiency of a well-designed propeller lies between 0.7 and 0.75, depending very largely upon the thickness of the blades. To obtain the best results, bronze propellers should be used in preference to cast iron, the superior strength of the former permitting the use of a smaller thickness. The mechanical efficiency of the motor, or ratio of the brake to the indicated horsepower, has been assumed as equal to 0.75, this being a fair average of well-designed and constructed machinery of the motor boat type:

Formulas for Motor Boat Propellers.—

Let D = Diameter in inches.
R = Revolutions per minute.
$I.H.P.$ = Brake horsepower $\div$ 0.75.
V = Speed in knots (6,080 feet).
pr = Pitch ratio.
sr = Surface ratio.

Then, upon the basis of the fundamental expressions, and employing the coefficients and exponents derived from the results of experiments we have the two simple equations for practical use:

$$D \times V^{\frac{5}{2}} = 170\ I.H.P.^{\frac{1}{2}} \times pr^{0.4} \qquad (1)$$

$$8.3\ V^{\frac{5}{2}} = R \times I.H.P.^{\frac{1}{2}} \times pr^{1.3} \qquad (2)$$

A surface ratio of 0.36 has been assumed in framing the above formulas. For other values, multiply the revolutions and divide the diameter by the value of C corresponding to the selected value of the surface ratio as follows:

sr	*C*	*sr*	*C*	*sr*	*C*
0.30	0.96	0.38	1.01	0.46	1.04
.32	0.97	.40	1.02	.48	1.05
.34	0.99	.42	1.03	.50	1.05
.36	1.00	.44	1.04	.52	1.05

Given diameter: Substitute in equation (1) and solve for pitch ratio, substitute this quantity in equation (2), and solve for revolutions.

Given revolutions: Substitute in equation (2) and solve for pitch ratio, substitute this in equation (1) and solve for diameter.

Should the diameter or revolutions thus obtained be unsuitable, either one or the other will have to be modified in such a manner as to bring about the proper relationship. Should this be impracticable, it will be a sure indication of a reduced efficiency of propulsion, and a lower speed will have to be accepted.

promenade for passengers when the climate is more congenial.

On the main deck is a large apartment for the exclusive use of first-class lady passengers. Immediately below this apartment is the gentlemen's smoking saloon, framed in paneled oak, and upholstered in rich leather. Abaft this is the restaurant, capable of accommodating fifty passengers at a time. The galley on the deck above communicates with the pantry by means of a hoist, and is fitted with a very complete installation of cooking appliances. The second-class accommodation is situated aft; the ladies' cabin on the awning deck, and the gentlemen's accommodation on the lower deck. A large open space is also provided on the main deck as a shelter during day service. The crew are accommodated on the lower deck aft, and the officers and engineers on the main deck above them.

The appliances for working the vessel are exceptionally powerful, and consist of a large windlass and capstan at the fore end of the vessel, a warping capstan aft, and two warping capstans, one at each hatchway. The rudder, which is of large area, is of the balanced form, specially designed by the builders for their turbine vessels, and is worked by a steam tiller, controlled on flying bridge by means of a telemotor. For convenience in canting and backing out of both English and French harbors, the vessel is fitted with a large bow rudder worked by steam steering gear.

The vessel is heated by steam throughout the passenger accommodation, and is fitted with electric light and bell installation. The sidelights are of the Denny-Porterfield patent pattern.

THE TURBINE STEAMER VICTORIA, BUILT BY WILLIAM DENNY & BROTHERS.

Another Turbine Channel Steamer.

William Denny and Brothers have launched at Dumbarton the turbine steamer *Empress*, of 1,700 tons, sister ship to the *Victoria*, for the South Eastern & Chatham Railway Company. The *Empress* is also intended for this company's cross-channel service. She is 310 feet long, with a molded breadth of 40 feet and a depth of 24 feet 6 inches to awning deck, which extends from stem to stern. In large deckhouses on this deck there are a number of special cabins provided for first-class passengers. The smoking room, in fumed and polished oak, is of a free classic design, the upholstery being in leather. Above this accommodation there is a long promenade deck, extending out to ship's side, which shelters the awning deck in wet or rough weather, and provides a large

The propelling machinery, supplied by the shipbuilders, consists of three turbines, each driving a separate shaft and propeller. The horsepower is 8,000, and the designed speed is 23 knots.

United States Shipbuilding.—The monthly reports of the Bureau of Navigation show a construction during August of 124 vessels of 57,205 gross tons, or an average of 461 tons. The September figures are 102 vessels of 45,489 tons, or an average of 446. Steel steamers accounted for 14 vessels and 46,613 tons in August, the average being 3,330 tons; and 11 vessels of 40,146 tons in September, averaging 3,650 tons. In each case the Great Lakes accounted for upwards of 70 percent of the tonnage of steel steamers, there being 34,756 tons in August and 29,502 in September. In August six of the

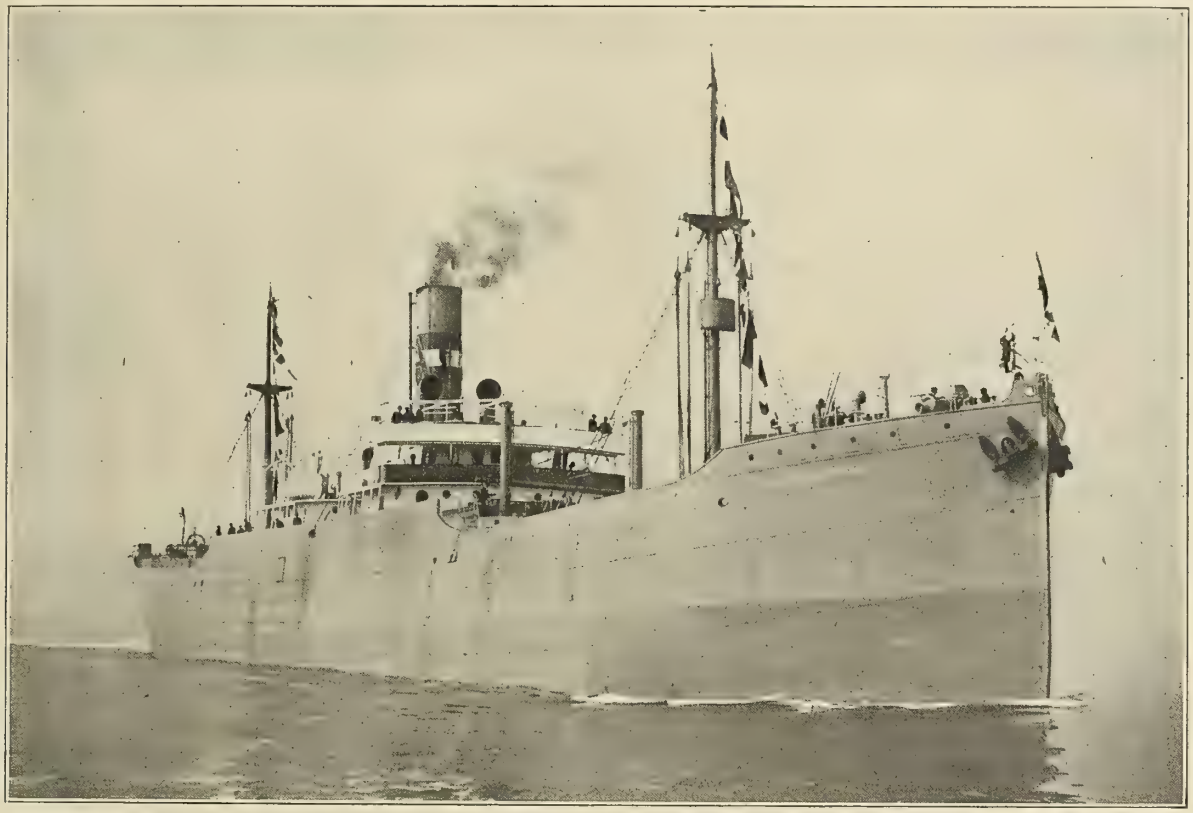
seven ships of over 4,000 tons each were built on fresh water; and in September, also six out of seven. The largest vessel in August was of 7,962 gross tons; in September, 6,530 tons.

British-Built Ships for Hungary.

On February 28, 1907, Messrs. William Gray & Company, Limited, West Hartlepool, launched the steel screw steamers *Magyarorszag* and *Szterenyi*, two of four ships which they have built for the Atlantica Sea Navigation Company, Ltd., of London and Budapest. All four ships are alike in design.

Each will take the highest class in Lloyd's Register, and is of the following dimensions: Length over all 342 feet, breadth 48 feet 3 inches and depth 24 feet 6 inches, with extra long bridge, poop and topgallant forecastle.

The hull is built with deep frames, dispensing with hold beams and leaving large clear holds; cellular double bottom and large aft and fore peak ballast tanks. Eleven steam winches, steam steering gear amidships, hand-screw gear aft, patent direct steam windlass, large marine-type donkey boiler, provision for shifting boards throughout, stockless anchors, telescopic masts, boats on beams overhead, electric light throughout, form a very complete outfit for a first-class cargo steamer.



THE HUNGARIAN STEAMSHIP MAGYARORSZAG ON HER TRIAL TRIP, AT LIGHT DRAFT.

Triple-expansion engines were supplied by the Central Marine Engine Works of the shipbuilders, having cylinders 24, 40 and 65 inches in diameter, with a piston stroke of 42 inches, and furnished with steam by two large steel boilers for a working pressure of 180 pounds per square inch. The engine room is replete with auxiliaries, including a Kirkaldy feed heater, Boothman feed filter and Mudd's evaporator. The boilers, etc., are covered with S. T. Taylor & Sons' "Tynos" non-conducting material, and the boiler bottoms with Tynos removable asbestos mattresses. The performance of both ship and machinery on the trial trip of the *Magyarorszag*, March 28, was entirely satisfactory, the average speed of the vessel being 11 knots.

THE VESSEL OF THE FUTURE.

BY ARTHUR R. LIDDELL.

The oversea shipping interests of America have a grand opportunity before them. While Congress and the nation are determined to win back at least a portion of their old share of the carrying trade, their merchant fleet is almost non-existent. The advantage of this black-looking state of things is that the men who are to create the new fleet can start free from the trammels of tradition, and are not obliged to bargain with the owners of antiquated material. Just as Sir Christopher Wren and Inigo Jones were free to inaugurate a new architectural era after the fire of London, so may the naval architects of America grasp the present opportunity of creating a prouder and better merchant navy than the world has yet seen. The old world ship is the outcome of half-understood scientific principles, badly devised methods of assessment, and imperfect acts of Parliament, which legislators do not find time to amend.

In regard to the direction which reform might take, the following consideration may be submitted:

It is said to be difficult or impossible to determine the forces which act upon the structure of a vessel in a seaway, and recourse has hitherto been taken to the make-shifts embodied in the rules of the older classification societies as measures of the results of practical experience. The above assertion may be generally true, and the classification societies referred to have no doubt done good work according to their lights, but it is surely time to ask whether more suitable units of measurement may not be devised.

When calculations are resorted to to determine the scantlings, it is usual to assume the vessel in question as resting successively on the crest and in the trough of waves of her own length. It appears to be forgotten that this condition of things is practically an impossible one. It is imaginable for a vessel that steams with the waves and at their speed, but the vessel would, in proportion to her length, have to steam

as fast as a torpedo-boat can do in smooth water, and it is well known that such craft steam much more slowly in a high sea.

The length of an ocean wave being equal to the square of its speed in knots $\times$ 0.562, a vessel of 200 feet in length, to keep pace with a wave of her own length, must steam at about 19 knots. As a matter of fact, this assumed condition is not the determining one. The center of gravity of an end half of a vessel being taken as fixed, the varying distribution of buoyancy of this part, due to the passage of a wave, will have an upward resultant acting sometimes before and sometimes abaft it. In other words, couples will be formed, tending to tilt the end-half towards and away from the midship section, alternately. In addition, there is a heaving motion, which to a greater or less degree neutralizes the bending strain set up by the variation in the longitudinal distribution of the buoyancy. Its amount, however, is difficult to determine, and may for the present be disregarded.

Whatever the intensities of the bending strains, the agency which causes them is the disturbance which takes place in a horizontal slice of the vessel, thicker at the ends than in the middle, within which the surface of the water undulates. Further, the intensity of these strains are greatest when the vessel is steaming over waves of her own length. Now the heights of waves that have been observed in different seas have varied about in proportion to the square roots of their lengths, and their periods also vary in this proportion. The work done by the moving water, then, varies as the area of the waterline $\times$ $\sqrt{\text{wave length}}$ $\times$ wave period, or as area of waterline $\times$ $\sqrt{\text{wave length}}$ $\times$ $\sqrt{\text{wave length}}$, or, again, as area of waterline $\times$ length. Subject, perhaps, to a correction for heaving, the work done appears to be equal to the moment of resistance of the waterline $\times$ length $\times$ a constant a.

Again, the bending strain of the vessel amidships is equal to the moment of resistance of the midship section $\times$ a constant b. The work done in bending the vessel being equal to that done by the material in resisting the bending, we have

$$M.\ R.\text{ of midship section} \times a = M.\ R.\text{ of waterline} \times b,$$

$$\text{or } \frac{M.\ R.\text{ of midship section}}{M.\ R.\text{ of waterline}} = \frac{b}{a},$$

where b and a are both unknown. The quantity $\frac{b}{a}$ may be replaced by a simple unknown x. A scientific determination of the value of x involves extremely difficult calculations, and in the present state of our knowledge is probably impracticable. It is possible, however, to determine it from the results of practice, as follows:

The rules and tables of the classification societies are the outcome of the system of trial and error as applied to actual vessels. For good ordinary designing, the proportion borne by the moment of resistance of the midship section may be taken as a suitable one. It would probably be feasible to substitute the scantlings corresponding with a moment of resistance of the midship section which would satisfy the equation

$$M.\ R.\text{ of midship section} = M.\ R.\text{ of waterline} \times x$$

for those of the tables, if once the value of x were determined from these latter.

It may be said, Why calculate when there are tables to go by? The answer to this is, that the tables are suitable for normal vessels only, and for sizes that lie within their compass. The numbers which regulate the scantlings are not so framed as to take into consideration all the circumstances of a design, such as coefficient proportion borne by depth to breadth, etc., and those adopted by the different societies do not always give identical results.

It may, for example, be assumed that for a given longitudinal number the scantlings will sometimes be just sufficient, and sometimes unnecessarily strong, according to the proportion borne by breadth to depth of the vessel, and so on. It would probably satisfy present requirements if a value of x were determined for each number (probably this value would be found to be nearly constant), and it were made permissible for scantlings either to be determined by calculation or to be taken from the tables. The somewhat laborious calculation would often result in a considerable saving of weight and money. Designers who could not afford the time for it would then work to tables as before. Further, the degree of fullness of the load waterline, which undoubtedly exercises an influence on the bending of the vessel, would thereby be taken into account.

Were such a method adopted, extreme dimensions would lose their present importance. Yacht forms might in many cases replace the boxes now fashionable, and material would be apportioned to the work required of it. The moments of resistance of waterlines of different coefficients of fineness, or coefficients for these, could for ordinary vessels be given in tabular form, so the moment would become = Length^2 $\times$ breadth $\times$ coefficient.

The transverse structural arrangements of vessels are perhaps even more in need of reform than the longitudinal ones. The ship of the future which, according to the prophets, is to be several times as large as the largest ocean liners now running, is generally depicted with nearly as many stories as a New York sky-scraper, most of them extending over from ¼ to 1/3 of the length amidships. In the deck beams there is, in proportion to the size of the vessel, many times more transverse strength than is found necessary in many a one-deck or two-deck vessel which now successfully navigates the ocean.

For convenience in the framing of rules, the classification societies have fixed the maximum height of decks at 8 feet, under penalty of additional stiffening of the vessel's sides between these. The extra requirements are such as to deter the naval architect from making small additions to 'tween-deck height, and up to the present he has not been bold enough to ask for large ones. If we could build to the laws of nature alone, there seems no reason why large vessels should not, without alteration of their draft or under-water form, have increased freeboard and loftier rooms. Provided breadth and draft remain unaltered, the extra height of vessel thus obtained ought, within certain limits, to justify reductions in the scantlings of the longitudinal structure; for the longitudinal bending forces vary as the moment of resistance of the waterline, which here remains unaltered, while the moment of resistance of the midship section increases with the height of the vessel. A style of construction which is gradually coming into fashion is the replacing of the rows of deck stanchions hitherto employed by one or two very strong pillars in the length of each hold, and the connecting of these with longitudinal girders at the decks. With the ordinary height of 'tween-deck, the presence of the girders reduces the headroom to such a degree that the employment of the new style of construction has in many cases been confined to the lower hold.

If the deck-heights be increased as proposed, the headroom difficulty at once falls away. The girders, extending from bulkhead to bulkhead, may be so proportioned that they can carry the decks. The beams can then act as local stiffeners, and be made of very much lighter section. Even when thus lightened, the beams may still be made to afford considerable transverse strength, and this, added to that given by the numerous watertight bulkheads, will, at any rate in a passenger steamer, be quite sufficient for all purposes. Increased height of 'tween-decks would have to be accompanied by

increased section of the transverse frames, but the saving in weight on the whole structure would still be very considerable.

The outcome of the above structural reforms will be a larger, lighter and cheaper vessel, which will be able to carry more powerful engines, and give better accommodation to, perhaps, fewer passengers—but the payment of dues will be assessed on its large internal capacity in an utterly unwarrantable manner. It might be reasonable to levy dues on a vessel in proportion to services rendered to her, and these might bear some relation to her length, breadth and draft, but hardly to her height. The principle of taxing her earning power, which underlies the present tonnage laws, is applied in a manner which is certainly inadvisable, inasmuch as space can be, and is, curtailed, in order to keep the assessment small. This is as baneful to comfort on the sea as were the old-fashioned taxes on doors and windows to that upon land.

It may be objected that loftier rooms mean reduced earning power; but is this not the case on land also? There are doubtless many passengers who would willingly pay more for better accommodation, and, moreover, the increase in cost need not be so inordinate, provided the methods of assessment be reformed.

To return to the laws of nature, the limit to the increase of height contemplated is the stability. This may with advantage be relatively small in larger vessels. A small vessel is liable to isochronous rolling, i. e., the magnitude of her successive inclinations to starboard and port increases gradually up to a dangerous degree when she meets with waves of the same or about the same period as her own. In the case of a well-proportioned vessel of 1,000 feet in length, the waves that could thus become dangerous would be longer than any that are met with at sea. The large vessel can, therefore, afford to steam with a small degree of stability, and this in itself makes her motion easier, and adds to the comfort of her passengers to a very high degree.

Looking at the problem broadly, it would appear that, with increased dimensions, vessels will gradually have less and less to fear from the waves, and can be made relatively lighter, roomier, and more comfortable, until their general conditions approach those of the smaller craft which now navigate the rivers, though, of course, on a larger scale.

What is needed is reform, and reform will be encountered by difficulties. Will the Americans grapple with and overcome these? If dues are to be levied on the earning power of vessels, why not levy them upon the actual gross or net earnings, and leave the naval architect a free hand to improve the sea-going hotels, and make traveling from continent to continent a less trying ordeal than it now is?

If America were to give up dues levied on the cubic capacity of vessels, and to tax their earnings instead, roomier vessels would result. In the first instance, no doubt, others would adhere to the present system and levy disproportionately large dues. Passengers would, however, give the better vessels the preference, even at higher charges, so that the loss would be made good again, and the foreigners would have to adopt the reform themselves, or be content to lose much of their passenger traffic. As a rule, large liners run between certain definite ports, and the value of the services rendered to them at these can be established. Arrangements which would fairly remunerate dock companies and others, without influencing the build of the vessels themselves, could certainly be arrived at if only the advantages of reforms in this direction were appreciated.

With regard to safety in case of collision, large, high-sided vessels of the kind proposed would be better off than those now running. They can, without much inconvenience, be provided with more watertight subdivision—perhaps from ¼ to 1/5 more—and they will have more spare buoyancy on account of their increased height of side.

It has sometimes been asked by warship constructors why merchant vessels have such box-like forms. In their own designs they also have to make the most of the available displacement, and the result is generally a much shapelier and more finely-lined vessel. It is generally answered that the merchant vessel has to float at widely differing waterlines, and that wall-like sides provide the sea qualities required under the various conditions of loading. The reason given is not the only one. Classification societies and others find it convenient to determine the scantlings more or less in relation to the circumscribing parallelopipedon, and thus make an approximation to this form the cheapest. The latter gives the largest vessel that is consistent with the "principal dimensions," and that will keep within the scantling grade. Were the moments of resistance of waterline and midship section made the deciding factors, the fine entrance and fine run favorable to easy driving at high speed might be provided at less cost.

The foregoing bears reference chiefly to the conditions which affect large passenger steamers. For ordinary cargo vessels the problem becomes somewhat different. Deck beams may have to be strengthened for the support of heavy weights of cargo, and watertight subdivision may be carried out to a less considerable extent. In general, however, similar reforms may be applied to them. Their assessment for dues may be a less simple matter than that of a regular liner, but a tax on their value, or on the business done by them, say, as an average of a certain number of years, which will be better than the present indefensible arrangement, may surely be devised.

In the case of war vessels the equation

$$M.\ R.\ \text{of midship section} = M.\ R.\ \text{of waterline} \times x$$

ought to be useful in determining the scantlings of the longitudinal structural parts in passing from smaller to larger vessels of a given class, or vice versa. In these vessels the longitudinal distribution of the weights for different conditions of loading, that is, for cases in which greater or smaller amounts of coal or ammunition are on board, is determinable.

If the longitudinal distribution of the weight in a given case be different from that of the buoyancy, a calculable permanent bending moment will be acting on the vessel, tending to make her sag or hog, as the case may be. This will be taken up by the material of the longitudinal structure in such a manner that the moment of resistance in the one direction—say that to resist hogging—will in effect become less, and that to resist sagging greater, by a certain given amount. The reduced hogging moment and the increased sagging moment will then be available to resist the alternating upward and downward bending moments due to the passage of the waves. It may thus appear advisable from the beginning to distribute the material in such a manner that there is an excess on the upper or lower works, as the case may be, such as will make up for the permanent bending moment mentioned.

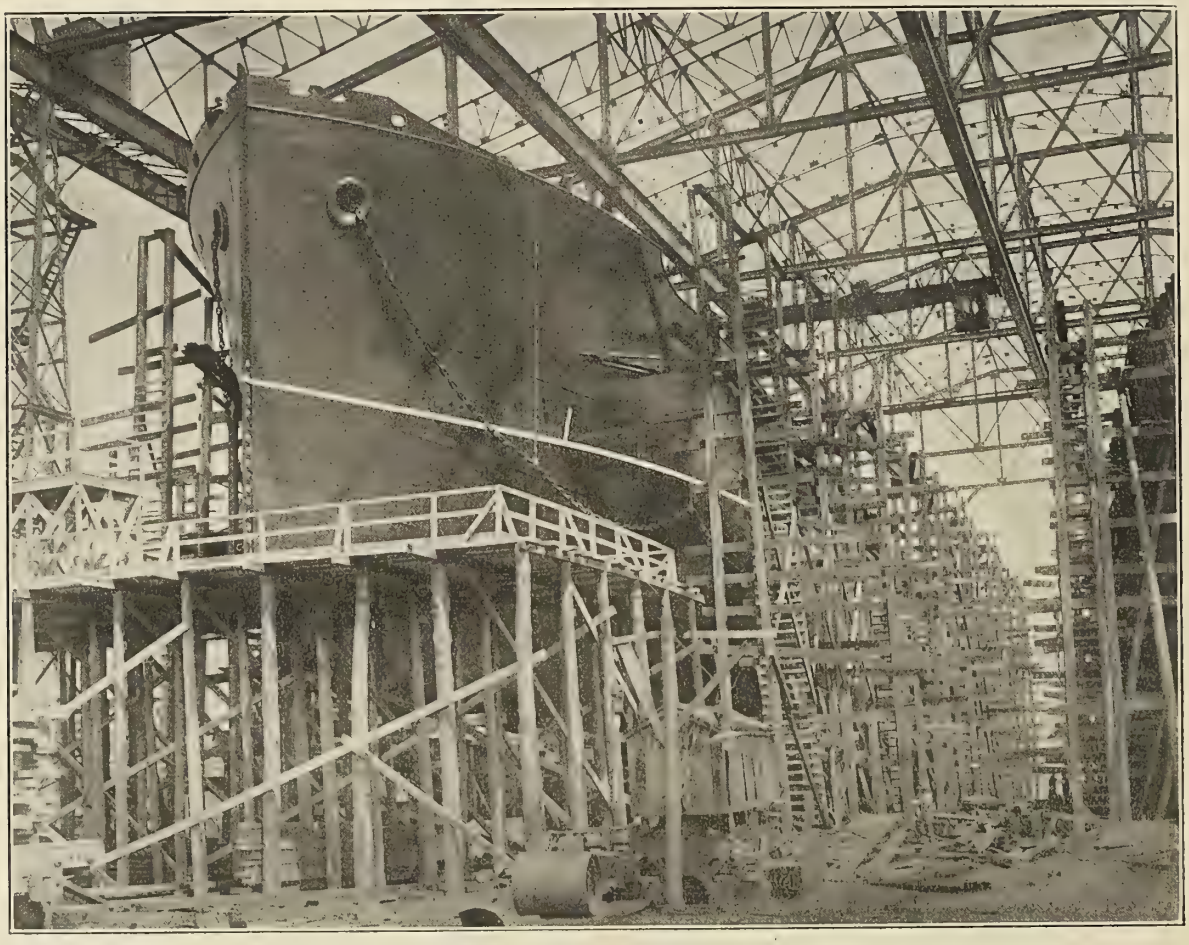
The calculation of the bending moment of a vessel is a somewhat laborious operation, but if a method like the one proposed for the determination of scantlings were generally accepted, the reduction in material, which might sometimes be made, would more than repay the extra work. Naval architecture has too long depended on "rules of thumb." If real progress is to be made in it, more attention must be paid to the laws of nature, and the present taxes on good design must be abolished.

The screw steamship *Mineola*, 4,766 tons gross and 3,129 net, is being fitted out at New York for a yachting cruise around the world. She measures 390 by 50.7 by 31.3 feet, and is propelled by a triple expansion engine with cylinders of 25½, 44 and 75 inches, by 51 inches stroke.

NEW STEEL STEAM COLLIERS.

The steamship *Everett* is the first of three similar vessels designed and constructed by the Fore River Shipbuilding Company, of Quincy, Mass., for the New England Coal & Coke Company, of Boston. The others are the *Malden* and the *Melrose*. Each vessel is intended for the coal trade between Boston and the South, and is of the following dimensions:

Length over all	400 ft.
Breadth, extreme	53 ft.
Depth	32 ft. 6 in.
Gross tonnage, about	5,340



BOW VIEW OF THE STEEL SCREW COLLIER EVERETT IN FORE RIVER SHIPYARD.

The *Everett* is a single screw steamship of the single-deck type, with long poop, bridge and forecastle, and constructed on what is known as the self-trimming system. This consists in sloping the hatchways from their side coamings to the side of the ship, having an angle of about 45 degrees, the triangular prism formed by this line with the topsides on the spar deck being cut off and utilized as topside ballast tanks, to be filled with water when the vessel is running light. In addition to these ballast tanks, a deep inner bottom is provided right fore and aft for the carriage of water ballast, in addition to the usual fore and after peak tanks. The great capacity for water ballast thus provided will insure a good immersion of the vessel when in the light condition, thereby providing greater stability, and guarding against emersion of the propeller in this condition. This system of construction is a special feature of these vessels, and the structural arrangements incorporated are novel in ship construction.

The vessel will be rigged with three pole masts, and the machinery located right aft. The hull is built right up to a long poop deck aft, which incloses the engine and boiler casings, reserve coal bunker, and accommodations for firemen, seamen and oilers and their wash places. On top of this deck there has been constructed a steel "Liverpool" house, in which have been arranged commodious state-rooms for the berthing of the chief engineer and his assistants, together with mess rooms, bathrooms and toilet arrangements.

The bridge deck, with sides of ship built up supporting same, has been constructed well forward of the half length. In this inclosure there have been provided the officers' accommodations, dining-room, bath-rooms, spare state-rooms, ice-room, pantry, store-room, etc. On top of this deck a steel chart house has been arranged, with access stairway from spar deck to this house. In addition to the chart house, at the forward end commodious quarters have been provided for the captain, with bathroom adjoining.

The pilot house, which is a specially handsome structure, strongly built of teak and finished bright, is arranged overhead, with navigating bridge in front of same, and above this, with access therefrom, a flying bridge with electric projector, standard compass and steering station has been provided.

The forward part of the vessel has been carried up, forming a top gallant forecastle about 36 feet long, on which has been installed a powerful steam windlass of the latest type operating stockless anchors.

The *Everett* has been subdivided by transverse watertight bulkheads into five large cargo holds, each about 48 feet in length, specially constructed for the stowage of coal or mineral cargoes, each hold being operated through two cargo hatches 28 feet in breadth by 14 feet in length. The hatch covers are of steel, and of special construction, to insure absolute watertightness and quick handling of the covers in opening and

THE STEEL STEAM COLLIER MALDEN AT QUINCY, MASS., AFTER DOUBLE LAUNCHING OF SEPTEMBER 10, 1907.

closing. These cargo holds provide for the stowage of 7,200 tons of coal, in addition to the bunker coal carried for steaming purposes. Arrangements have been made at the loading terminal for filling the vessel in about five hours, and discharging in Boston by means of grabs in little over double this time.

The ship has a machinery installation consisting of a set of triple expansion surface condensing engines having cylinders 28, 44 and 73 inches in diameter with a common stroke of 48 inches, all of which are fitted with piston valves. Steam is provided by four single-ended Scotch boilers 14 feet 2½ inches mean diameter and 8 feet 10 inches in length, each boiler being provided with corrugated furnaces of the latest pattern Morison suspension type, constructed for a working pressure of 180 pounds per square inch. In addition to these boilers, a donkey boiler is carried for auxiliary purposes. It is anticipated that this machinery installation will insure a continuous sea speed of 11 knots when fully loaded, making this class of vessel the swiftest, as they are probably the largest, of their type afloat.

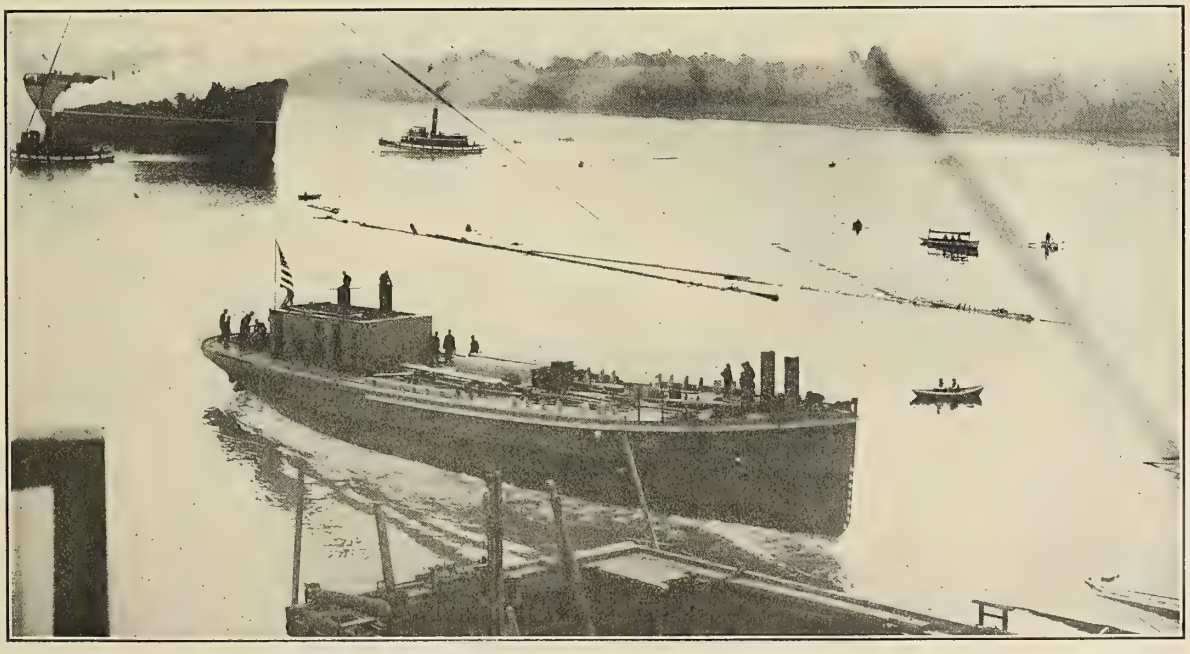
It may be said that the *Everett* and her sisters have been specially strongly constructed to withstand the hard trade in which they will be engaged. The scantlings are in excess of the United States Standard Register requirements, to whose survey they have been specially constructed with a view to obtaining the highest class which this society awards. It need hardly be said that in first-class vessels of this description special attention has been given to the berthing and messing of officers and crew, these being especially commodious, well lighted, furnished and ventilated, so that although engaged in the coal trade the complement will be berthed in as comfortable a manner as that obtaining in ordinary passenger vessels.

The stern frames for the three colliers were built by the Fore River Shipbuilding Company, and are fine examples of complicated steel forging. The dimensions of this massive forging are:

Weight	13½ tons.
Sectional width	11 ins.
Sectional thickness	7 ins.
Length of rudder post	36 ft. 8 ins.
Length of heel	17 ft.
Length of spur	6 ft. 6 ins.
Length of propeller aperture	21 ft. 6 ins.
Width of propeller aperture	7 ft. 5 ins.
Diameter of boss (inside measure)	2 ft. 1½ ins.

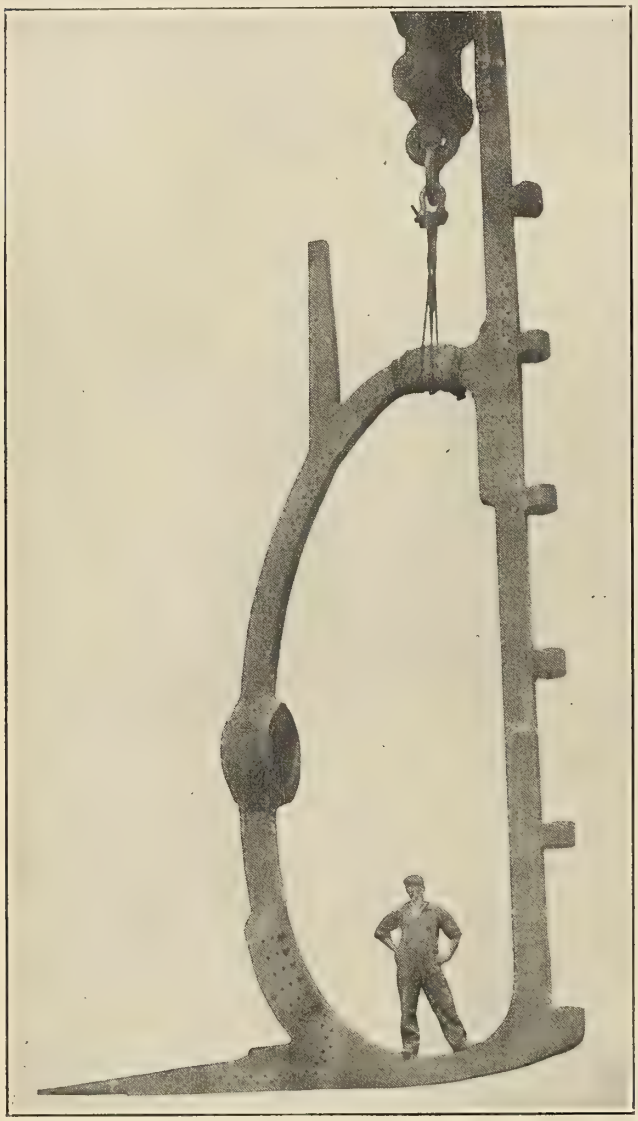
This stern frame was forged from 80,000-pound ingots of a special grade of low phosphorus and sulphur steel showing the following physical characteristics from a test specimen cut from a full-size prolongation of the forging:

Tensile strength	51,350 pounds per square inch.
Elastic limit	31,200 " " " "
Elongation	38 percent.
Contraction of area	65.63 percent.



THE STEEL STEAM LIGHTER NEW ENGLAND WAS LAUNCHED FIFTEEN MINUTES AFTER THE MALDEN.

It is obvious that metal exhibiting such an amount of elasticity and ductility has many advantages over the usual wrought iron product, particularly when viewed from a mechanical standpoint. As the practical man is aware, heavy wrought iron forgings are more or less spongy, requiring sub-



CAST STEEL STERN FRAME FOR THE COLLIER MALDEN.

sequent "doctoring" to patch up bad welding which often but veneers a bad interior. Properly melted steel ingots, on the other hand, produce homogeneous forgings free from these weld troubles, and, aside from a tendency to somewhat more rapid corrosion, insure a more reliable forging. The method of scarfing the two sections facilitates repairs to the portion most liable to accident.

For the quarter ending September 30, the construction of vessels in the United States is reported as 330, of 133,092 gross tons, or an average of 403 tons; as compared with 296 ships, of 102,748 tons, or an average of 347 tons, in the third quarter of 1906. The steel steamers included were 36, of 109,985 tons, in 1907, the average being 3,055 tons; and 32, of 82,916 tons, in 1906, at an average of 2,591 tons. On the Great Lakes the steel steamers this year were 17, of 75,830 tons, or an average of 4,461 tons; as compared with 14, of 70,107 tons, averaging 5,008 tons. The tonnage percentages for the lakes, as compared with the total of steel steamers, were 69 in 1907 and 84.5 in 1906. The Atlantic seaboard has shown a gain from 18 vessels of 12,809 tons to 17 ships of 31,533 tons.

Navigation by Celestial Observation. II.

BY STEPHEN P. M. TASKER.

LATITUDE.

That you may better understand how to get your latitude, we will explain the theory or principle. In Fig. 3 the circle represents the earth, with lines showing north and south poles, the equator, and the ecliptic, or line on which the earth moves around the sun from left to right. Let *A* represent your position anywhere on earth; the zenith is the point directly overhead, and the horizon is at right angles. As the earth moves from one side of the sun, as it were, to the other in six months, the poles always remaining in a parallel position, the angle the sun makes with the equator will change from day to day, and this angle *E* is called the declination of the sun. The sun is above the equator in summer and below in winter. Now if we measure angle *B* with the sextant, and subtract it from ninety degrees, we get angle *C*, and angle *C* is equal to angle *D*, because as the sun and stars are so infinitely far off, the rays are almost parallel. In the case of the sun, a slight correction (called parallax) can be made. From the Nautical Almanac we can get angle *E* or the declination of the sun; then angle *E* plus angle *D* equals in degrees our position north or south of the equator in the summer season. In the winter season the declination, or angle *E*, must be *subtracted* from angle *D*, as the sketch will show. When to subtract, and when to add, or the changing of the seasons, can be found from the Nautical Almanac.

From the diagram you will see we must measure the angle the sun or star makes when we are nearest it, or when it is directly south. This occurs at noon with the sun, and at different times of the night with different stars. When a celestial body is on our meridian, or due south, it is neither rising nor setting; that is, it then appears to move just parallel to our horizon, and there is a good opportunity to measure it; time is, therefore, not important in latitude observations, because we can observe the instant when the star or sun is neither rising nor setting with the sextant itself.

You can have some idea as to when it is noon and simply get ready before that time, and keep measuring until the very highest elevation the observed body can reach arrives. Sometimes the sun is on the meridian truly north and south before our clock tells twelve, and sometimes after, never more than sixteen minutes either way, though from the Nautical Almanac you can find exactly to the second when the sun "souths" on each day of the year, and in this way save the time you would otherwise spend in waiting for it to reach its highest elevation. This difference between the time of noon as shown by the sun, and the time shown by a watch, is called the equation of time.

If the elevation is measured at sea, your angle is too large, on account of the curvature of the earth. The correction, called the correction for dip, can be taken from Bowditch's tables. This correction is the angle *E* in Fig. 4. You have measured the angle *F*, but the angle *G* is the true elevation desired, and this equals *F* minus *E;* that is, the measured elevation, minus the correction for dip. On land there is no correction for dip; we here use the artificial horizon and measure the angle *B*, Fig. 5. What we want is the angle *A*, and since *B* is twice *A*, we divide our sextant reading by two.

Rule as given by Professor Eric Doolittle, of the University of Pennsylvania, for finding latitude by the sun:

1.—Read the angle from the sextant, subtract (or add) the index error, as the case may be, and subtract the dip taken from Table 13 (Bowditch's Navigator).

2.—To the result so obtained add the semi-diameter of the sun for that day from the N. A., and add the parallax taken from Table 16. From the result so obtained subtract the refraction taken from Table 20 A.

3.—Subtract the remainder from 90°, and to the remainder

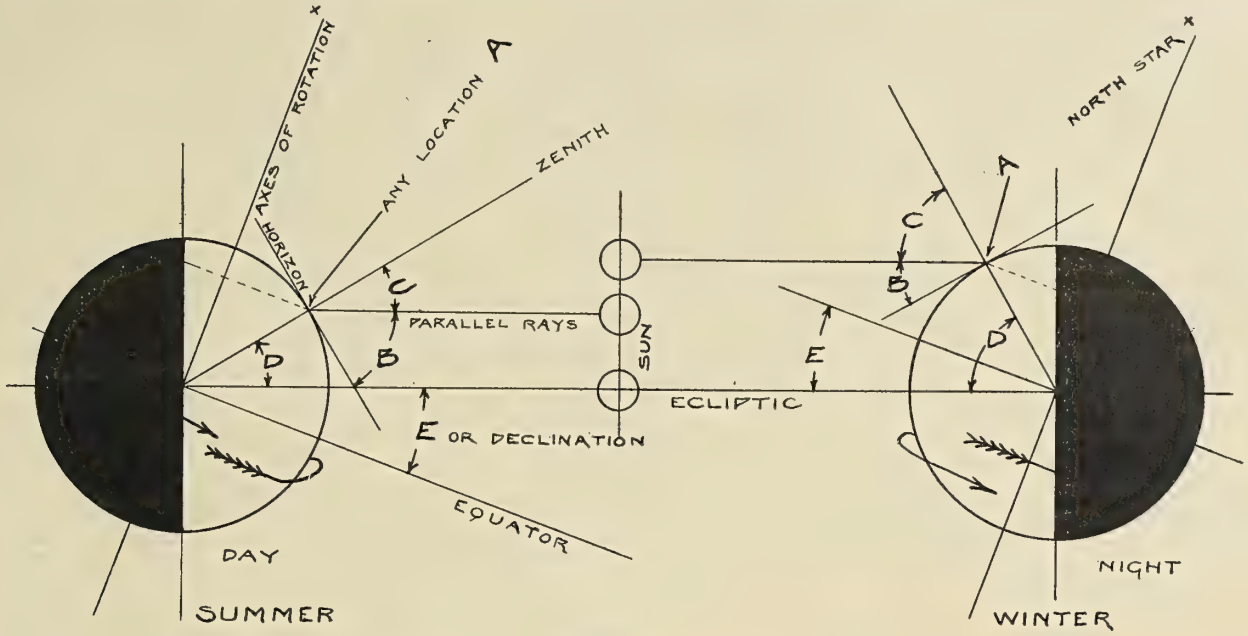


FIGURE 3.

so obtained add the sun's declination if this is north, but subtract if this is south (see N. A.). To the declination given in the N. A., correct for hourly change according to approximate longitude. The result will be the latitude.

For an example, suppose that the Nautical Almanac shows that the sun will be on the meridian at eleven hours fifty minutes. Sometime before this put in the telescope and adjust the colored glasses to suit the light in the sextant. Point the telescope at the sun, and move the arm of the instrument back until two images of the sun are seen, as in Fig. 6. Now depress the instrument, at the same time moving the arm forward, so that the reflected sun is kept constantly in the field. When the telescope is brought to point to the sea horizon, clamp the arm and throw up the colored glasses between the telescope and the sea horizon. Next point directly at the part of the sea horizon exactly below the sun, and move the arm slightly until the lower edge of the sun appears to touch this line, as in Fig. 7. Turn the instrument slightly back and forth about the telescope as an axis; the center of the sun will thus be made to move in a small arc *A B*, Fig. 8. The lower edge must be made to just touch the horizon when at the lowest point of this arc. If you do not move the arm the sun will keep separating from the horizon until the highest elevation or noon is reached, and then begin to sink again. But you must keep moving the arm ahead, so as to keep them just touching, as shown in Fig. 7, until the instant when they stop moving apart, and the sun begins to dip into the water. Then read the angle, and this is the angle corresponding to the highest or meridian position.

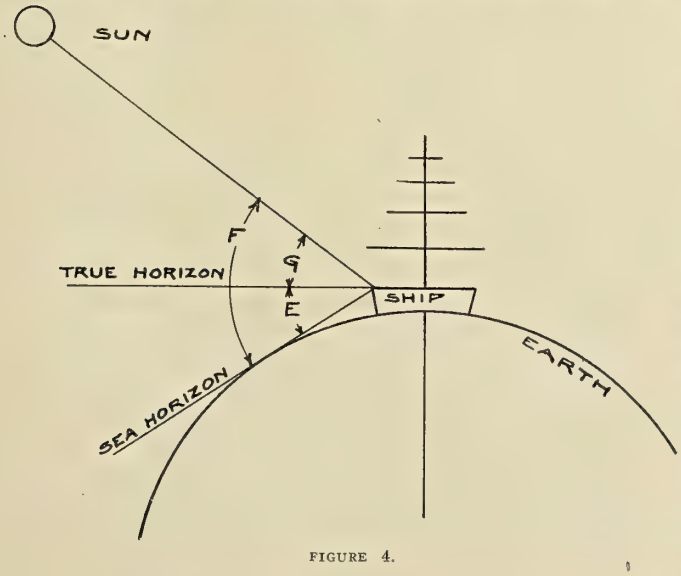


FIGURE 4.

EXAMPLE.

a. Observed altitude of sun, Nov. 11, 1905	35°	30′	10″
b. Index error (subtracted in this sextant)		1′	22″
	35°	28′	48″
c. Correction for dip, Table 13		4′	3″
	35°	24′	45″
d. Refraction, subtracted, Table 20 A		1′	22″
	35°	23′	23″
e. Parallax, add, Table 16			8″
	35°	23′	31″
f. Semi-diameter added (from N. A.)		16′	12″
Altitude corrected	35°	39′	43″
Subtracted from 90° (zenith distance)	54°	20′	17″
g. Declination, south, N. A.	17° 19′ 13″		
Ratio per hr. 41.73 ″ × 5 hrs.	3 29		
Total declination	17° 22′ 42″	17°	22′ 42″
Latitude equals		36°	57′ 35″

Explanation of the above:—*a* is read from the sextant, and is different every day.

b. All instruments have some slight error to make up for, and you can find this out by looking at a star directly through the telescope through the horizon glass, and bringing the image of the the same star reflected from the mirrors to coincide with the image seen directly in the telescope. If zero on vernier is then not in line with zero on arc, note the difference, and add or subtract, as the case may be, to all your observations. This is the index error.

c. The eye of the observer was about 17 feet above the water. The corresponding correction is taken from Table 13, and subtracted as explained above.

d. The atmosphere bends all rays of light coming from the

celestial bodies, and we must correct for it—Bowditch's tables.

e. Parallax is the error of measuring the sun from the surface of the earth instead of from the center of the earth. In stars there is no parallax.

f. Angles with the sun should be measured to the center of that body, but as in practice we always measure to the lower edge, the semi-diameter must be added. This changes from day to day. (See N. A.)

g. As the declination of the sun changes from day to day, to be accurate we should correct it by the hour. In this case the hourly change is 41.73 seconds, and as we are about on the seventy-fifth meridian (New York) or five hours from Greenwich, from which point all calculations are based, this hourly rate then multiplied by the number of hours east or west of Greenwich gives correction, and you add or subtract it, according to which way the declination is going. N. A. shows this.

i is the answer, and you get the latitude thus by knowing but very roughly, or not at all, your longitude or time.

If you are far north, and the sun at noon is so low down that you cannot observe it well, leave the sun and work on a

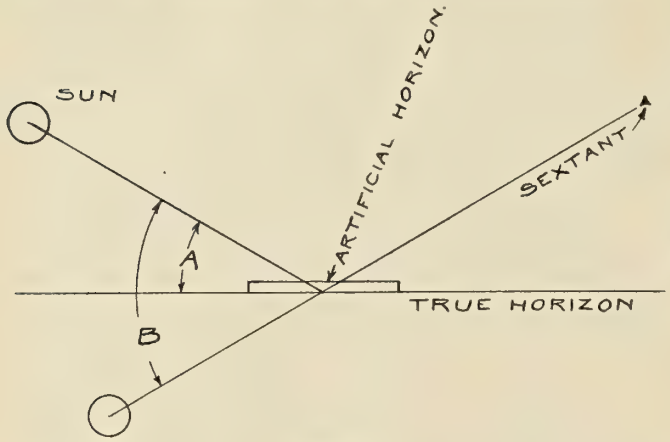


FIGURE 5.

star. There is the advantage of learning both sun and star observations. It is sometimes necessary to use one and sometimes use the other, the time of year and place of observation settling it. A very little practice at different intervals will explain and make this perfectly clear to the observer.

The sun is very handy, and in some latitudes can always be used for both latitude and longitude at all seasons; but, then, it is very easy to get so far north or south that the sun can be advantageously used only in summer, whereas one up in star work is absolutely independent of the sun. We will now look a little into that end of the observing, sufficient, at any rate, for the amateur's want.

TO FIND LATITUDE BY A STAR.

To know which star will cross the meridian after a certain hour; add that hour to the sun's right ascension. The sum will be the right ascension of your own meridian. If it is more than 24 hours, subtract 24 hours from it. The star table will then show you what star's right ascension is equal to or a little greater than your own. That will be the next star to cross your meridian.

How to find out at what time star will cross meridian:—Subtract the sun's right ascension from that of the star. If the latter is the smaller, add 24 hours to it and correct for equation of time. The remainder will be the time of the star's meridian passage.

You will know whether the star is north or south of you by its declination. If you are in north latitude, the star will be south of you if its declination is south, or if the declination is north and less than your latitude. If its declination and your latitude are both north, and the former is the greater, the star will be north of you. The same principle if you are in south latitude. The annual variation of declination is so small that the declination is not corrected; hence the chronometer time is not taken, and no allowance has to be made for semi-diameter or parallax.

Having measured the altitude of the star and corrected it

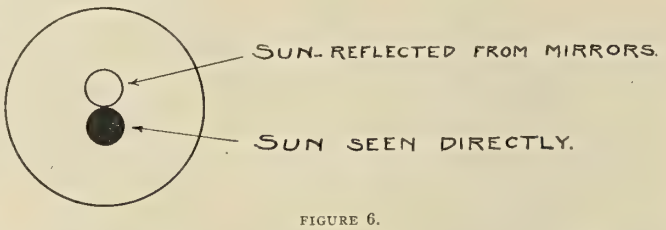


FIGURE 6.

for index error and refraction, you find the latitude by one of the following

Principles:—(1) Zenith distance = 90° minus corrected altitude.

(2) Latitude when star is below the pole = 180° minus declination of star, minus zenith distance.

(3) Latitude when star is between pole and zenith = declination of star minus zenith distance.

FIGURE 7.

FIGURE 8.

(4) Latitude when star is south of zenith and above equator = declination of star plus zenith distance.

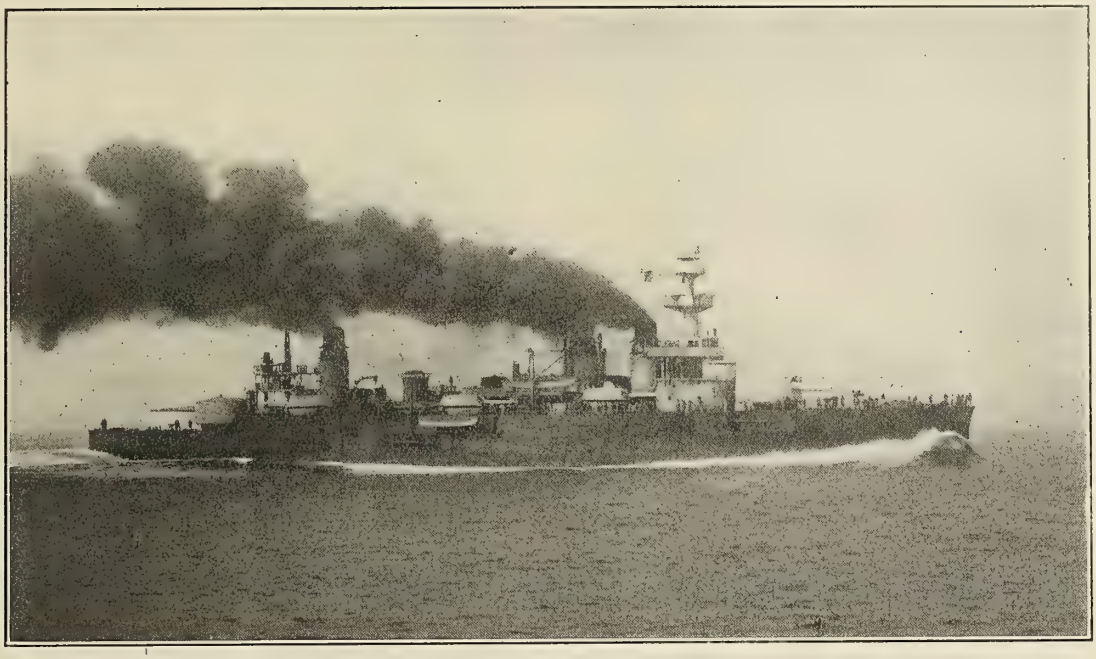
(5) Latitude when star is south of equator = zenith distance minus declination of star.

EXAMPLE.

Observed altitude of B Orion on 1-25-06	41°	48′	40″
Index error subtracted in this case		1′	18″
	41°	47′	22″
Dip, Table 13, corresponding to a height of 10 feet		3′	7″
	41°	44′	15″
Mean refraction, Table 20 A		1′	5″
True central altitude	41°	43′	10″
Subtract from	90°		
Zenith distance	48°	16′	50″
Declination of B Orion from N. A., south	8°	18′	39″
Latitude	39°	58′	11″

Certainly in the above example nothing could be easier or simpler. No semi-diameter or parallax. Just measure the angle the star makes with the ground, correct for the error of your instrument, dip, refraction and declination, and you have your latitude exactly.

Do not use a star for latitude that is too low down on its crossing your meridian, or one directly overhead; an angle of about thirty to seventy degrees is good. If the star is too high up, the sextant will not reflect it, and one too low brings



THE FRENCH BATTLESHIP DEMOCRATIE AT A SPEED OF 19 KNOTS, ON TRIAL TRIP.

in too much error with refraction. Also use only stars of first magnitude.

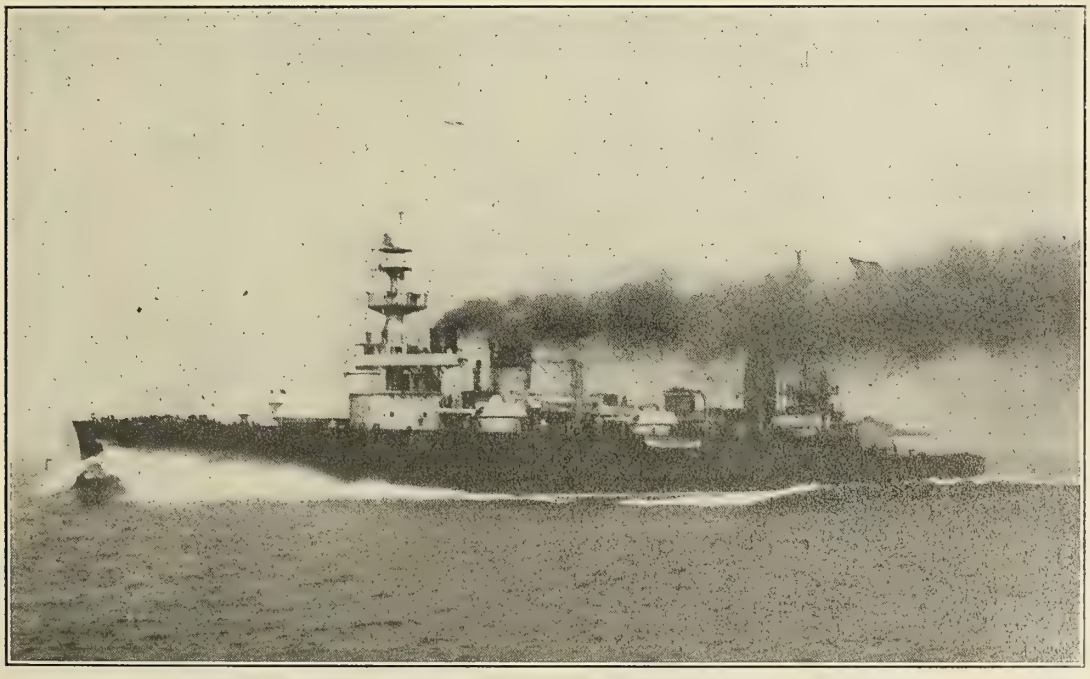
These terms of right ascension, etc., may seem confusing from the rules and at first sight, but with your Nautical Almanac and the few tables from Bowditch enumerated before, you can work out everything.

(*To be concluded.*)

Trials of French Battleships Démocratie and Justice.

These two battleships, which have recently finished their official trials, are the third and fourth of the 1900 programme, being sisters of the *République* and *Patrie,* described in our August number, and of the *Liberté* and *Vérité,* which are nearly completed. The ships have a load waterline length of 439 feet, an extreme beam of 79 feet 7 inches, and a draft of 27 feet 5 inches. The displacement is 14,867 tons, with a block coefficient of 0.543. An armor belt, with a maximum width of 18 feet 5 inches, has an extreme thickness of 11 inches, tapering to 3 inches at the ends. There are two protective decks.

The battery, which is a powerful one, consists in the first two of the type of four 12-inch guns mounted in pairs in two turrets, and eighteen 6.4-inch rapid-fire guns, of which twelve are in pairs in turrets and six are in casemates. The secondary battery includes twenty-seven 3-pounder and 1-pounder guns, and five torpedo tubes, two of which are submerged. A considerable difference exists in the battery of the last four ships of the type, through the substitution of ten 7.6-inch guns and eight 3.9-inch guns for the eighteen 6.4-inch guns on the first two vessels. This change makes for increased strength of broadside, particularly at long ranges. The 7.6-inch guns



THE FRENCH BATTLESHIP JUSTICE RUNNING AT FULL SPEED ON OFFICIAL TRIAL TRIP.

are located, six each in a single turret and four in casemates.

Each of the ships is propelled by three screws operated by triple expansion four-cylinder engines in separate watertight compartments. The cylinder diameters are 35, 49, 55 and 55 inches, with a stroke of 41½ inches. Steam is supplied by twenty-four watertube boilers, located in three boiler rooms, each with its own funnel. The total grate surface is 128 square meters (1,378 square feet), with a heating surface of about 46,000 square feet, making a ratio of 33.4 to 1. The boiler pressure is 251 pounds per square inch. The normal coal supply of 900 tons gives an estimated steaming radius at ten knots of 4,200 nautical miles. With the full coal supply of 1,850 tons, the estimated radius is increased to 8,500 miles.

It must be pointed out that for the first time since the days of the old sailing fleet France possesses a homogeneous squadron of six vessels of high power, it having until recently been the French naval policy to construct contemporaneous vessels on the divergent designs of various naval architects, resulting in the acquisition of a fleet which was described by one of the French admirals as a "museum."

The first two ships of this type were compared in our August number with the battleship *Virginia*, of the United States navy. The last four ships have a more powerful battery than the first two, but even with this advantage they could scarcely be expected to compete successfully with the ships of the *Virginia* class under ordinary conditions.

The results of the trials of the *Démocratie* and *Justice* are given in the table. The *Démocratie* is fitted with Belleville boilers, while the *Justice* has Niclausse generators. The poor propulsive efficiency at low speeds is more than offset by the magnificent results at 17 to 18 knots, while the figures for full speed are extremely good. It will be noted that, in passing from the intermediate to the highest speed, the index n in the expression $H_1 : H_2 :: V_1^n : V_2^n$ is very high, indicating a limit in highest propulsive efficiency at about 18 knots. This index, which is often assumed as 3, becomes 4.58 for the *Démocratie* and 5.98 for the *Justice*.

6-hour trial at low power.	*Contract.*	*Démocratie.*	*Justice.*
Boilers at work	5	5	5
Grate surface, square feet	287	287	287
Indicated horsepower	2,500	2,584	2,541
Consumption of coal in pounds:			
Per horsepower-hour		1.234	
Per square foot of grate			15.2
Mean speed in knots		7.5	7.8
Admiralty constant		98.8	112.8
Normal steaming radius		4,665	
24-hour consumption trial.			
Boilers at work		24	22
Grate surface, square feet		1,378	1,262
Indicated horsepower	10,500	11,472	11,520

24-hour consumption trial	*Contract.*	*Démocratie.*	*Justice.*
Consumption of coal in pounds:			
Per horsepower-hour		1.484	1.528
Per square foot of grate			14.8
Average speed in knots		17.39	17.94
Admiralty constant		277.6	303.2
Normal steaming radius		2,027	2,023
Full power 3-hour trial.			
Boilers at work	24	24	24
Indicated horsepower	17,500	19,190	18,548
Consumption of coal in pounds:			
Per horsepower-hour			1.824
Per square foot of grate	24.3	24.3	23.7
Average speed in knots	18	19.44	19.43
Admiralty constant	201.6	231.6	239.1
Normal steaming radius			1,140

The English Destroyer Mohawk.

The British naval estimates of 1905-06 included provision for eighteen torpedo-boat destroyers under three different classifications: twelve were to be coastal destroyers, with a length of 175 feet, a displacement of 225 tons and a speed of 26 knots, provided by Parsons turbine machinery of 4,000 horsepower. Of the other six, one was to be an experimental vessel of 1,800 tons with a length of 330 feet and the tremendous speed of 36 knots, provided by Parsons turbines of 30,000 horsepower. The other five, the launching of one of which we illustrate herewith, are of about 800 tons displacement and a speed of 33 knots, furnished by the same kind of motive power as the others.

THE FRENCH BATTLESHIP JUSTICE AT ANCHOR.

The *Mohawk* was launched from J. S. White & Company's shipyard, East Cowes, Isle of Wight, on March 15. She has a length of 270 feet and is fitted with three screws and one pole mast. The radius of action at an economical speed is estimated to be 1,500 nautical miles. The vessel carries three 12-pounder rapid-fire guns, and two 18-inch revolving torpedo tubes.

Propulsion is by means of five turbines, three ahead and two astern, driving the three shafts and accounting for a total (ahead) of about 14,500 horsepower. Steam will be supplied by six boilers of the White-Forster type, each of about 2,400 horsepower and fitted for burning liquid fuel, no coal stowage being provided in the vessel. The air pumps and pumps for forced lubrication, boiler feed, oil fuel, fire and bilge service, and the distilling plant are supplied by G. & J. Weir, Limited, Glasgow; the fans and circulating engines by W. H. Allen, Son & Company of Bedford; and the air compressor and electric light plants by Peter Brotherhood of London.

In this connection it is interesting to note that the first so-called "Torpedo Catcher" afloat came from this same yard in

THE TORPEDO DESTROYER MOHAWK TAKING THE WATER AT THE COWES YARD OF J. S. WHITE & CO.

1885. This vessel was the *Swift,* with a displacement of 125 tons, a length of 150 feet, a beam of 17 feet 6 inches and a depth of 9 feet 6 inches. She was propelled by a three-cylinder compound engine with cylinder diameters 20, 24 and 24 inches, and a stroke of 18 inches. The mean speed on the measured mile was 20.79 knots, with a boiler pressure of 126 pounds and an indicated horsepower of 1,387, the revolutions being 319 per minute.

The Brazilian Steamer Oyapock.

There was launched recently by Cammell, Laird & Company, Limited, at Birkenhead, a steel twin screw passenger and cargo steamer built to the order of the Lloyd Brazileiro, of Rio de Janeiro, and intended for their service between Cormuba and Uruguay. The dimensions are:

Length between perpendiculars	243 feet
Breadth molded	36 feet
Depth molded to main deck	12 feet

with a gross tonnage of about 1,750. She will carry about 450 tons dead weight of cargo and coal on a draft of water of about 8 feet, and have a trial-trip speed of 13½ knots.

The machinery consists of two independent sets of direct acting, inverted triple expansion engines capable of exerting collectively about 1,800 indicated horsepower, at 150 revolutions per minute. Steam is supplied by two single-ended boilers worked on Howden's system of forced draft with heated air and closed ashpits, each boiler having three corrugated furnaces with separate combustion chamber to each, and suitable for working at a pressure of 175 pounds per square inch.

The vessel has a continuous awning deck, with deckhouse extending practically the full length of ship, and containing staterooms and open cabins for the first-class passenger accommodation, with suitable fittings of hardwood. Above this deckhouse a spacious promenade deck is arranged at the fore end, with access from the house below. The arrangement of cabins, saloons, etc., throughout has been carefully designed for the comfort and convenience of the passengers, the cabins being handsomely decorated and furnished, a complete system of electric lighting being provided. Ventilation has also been made a special feature, insuring the maximum of comfort for passengers.

Accommodation for captain and pilots, together with chart room, is arranged in a deckhouse on the promenade deck forward, and forward of this is the navigating bridge. Provision is also made in the 'tween decks for about 200 third-class passengers. The galley arrangements, refreshment bar, etc., are on modern lines, and hospital accommodation is provided.

A complete system of Clayton's apparatus for fire extinguishing and fumigating purposes has been fitted. As regards her outfit of boats (having the Welin quadrant davits), life-saving appliances, hydraulic cranes for working cargo, and capstan aft, anchor gear, derrick arrangements and all accessories, the *Oyapock* is thoroughly modern.

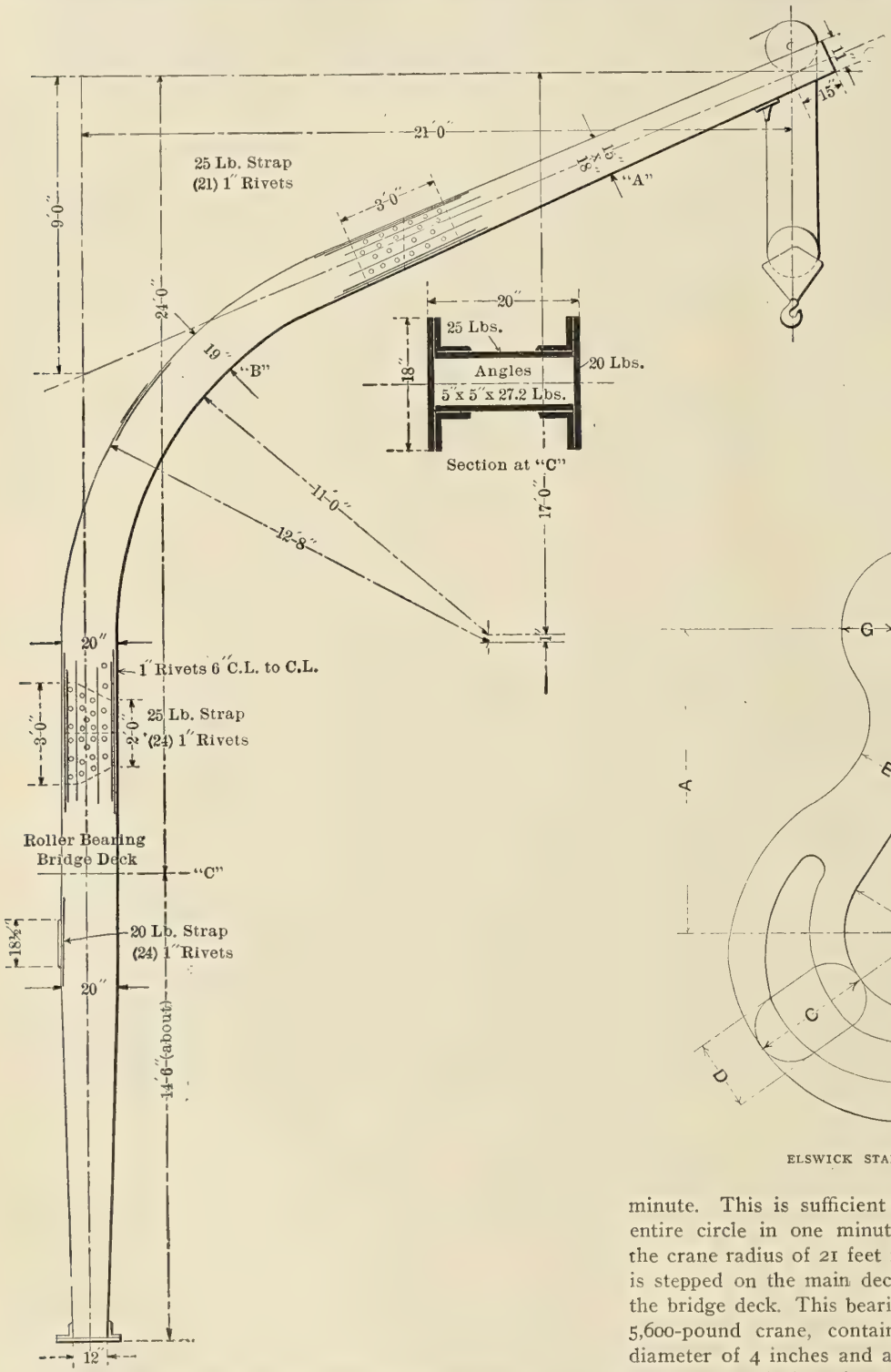
STEAMER OYAPOCK JUST AFTER BEING LAUNCHED BY CAMMELL, LAIRD & COMPANY.

On October 9, the William Cramp & Sons Ship & Engine Building Company launched for the Fall River Line, under joint contract with the Quintard Ironworks Company, the steel Sound steamer *Commonwealth.* The ship has a length over all of 456 feet, a waterline length of 439 feet, a molded beam of 55 feet, a width over guards of 96 feet, and a molded depth at side of 22 feet. She will be propelled at a high speed by paddle wheels, actuated by a double compound engine.

NOTES ON BOAT AND ANCHOR CRANES.

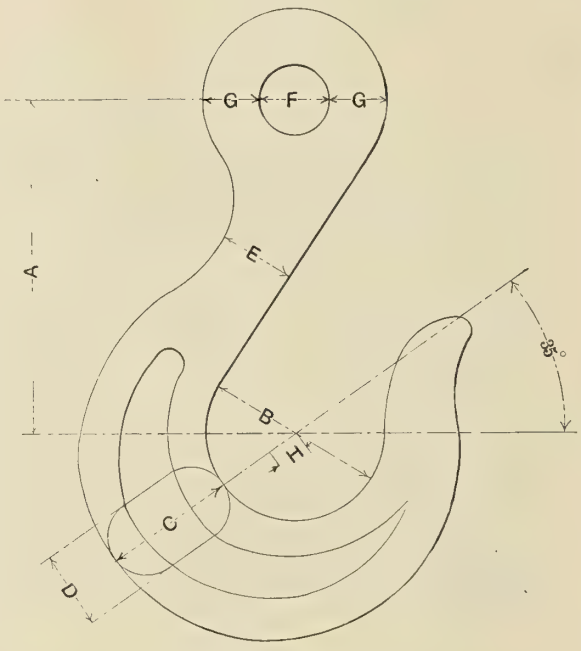
The several drawings show details of electrically operated cranes for the handling of boats and anchors on warships. They represent practice covering the last eight or ten years, and are given in considerable detail.

The first boat crane illustrated is that designed for the United States semi-armored cruiser *Milwaukee*. It was intended for a working load of 3,384 pounds, and was to be given a test load of double this amount. After this crane



BOAT CRANE (3,384 POUNDS) DESIGNED FOR MILWAUKEE.

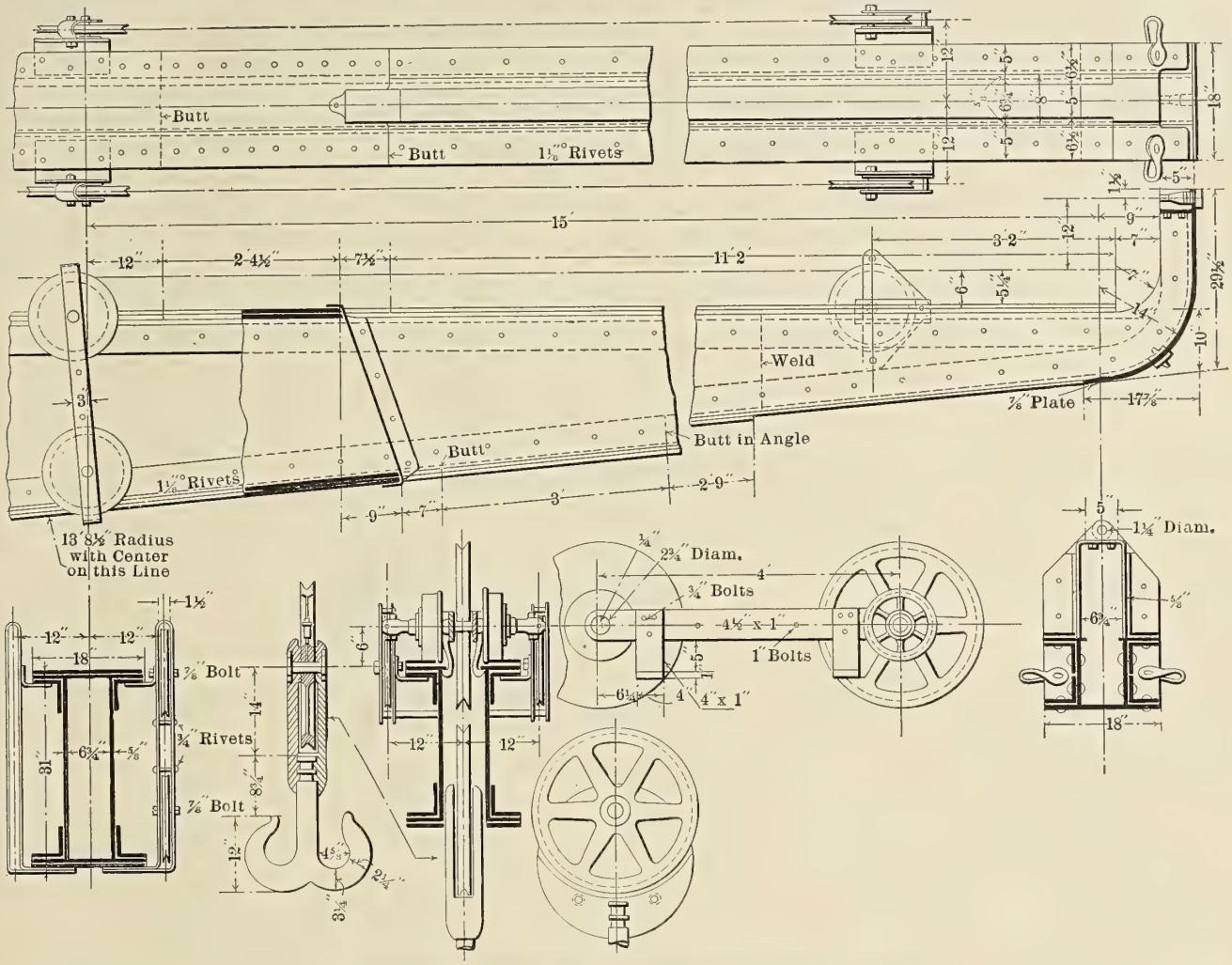
was designed a larger one with a capacity of 5,600 pounds, similar to that on the armored cruiser *California*, was substituted. The maximum working load on each rope is 1,692 pounds. The running rope is of galvanized steel with a diameter of ⅝ inch, the allowable working stress being 3,420 pounds per square inch. The hoisting drum has a circumference of 5 feet, the pitch diameter being 19⅛ inches; it is governed by both mechanical and electrical brakes. The hoisting motor is of 20 horsepower at 300 revolutions per minute. The hoisting speed is 40 feet per minute with full load, and 90 feet with the empty hook. The rotating motor is of 15 horsepower, and operates at 300 revolutions per



ELSWICK STANDARD CRANE HOOKS.

minute. This is sufficient to revolve the crane through an entire circle in one minute. The velocity of movement at the crane radius of 21 feet is 132 feet per minute. The crane is stepped on the main deck, and runs in a roller bearing at the bridge deck. This bearing, which is similar to that of the 5,600-pound crane, contains twelve rollers, each having a diameter of 4 inches and a length or face of 2½ inches. It may be noted that the moments of inertia at the points marked *A*, *B* and *C* are respectively 1,808, 3,211 and 3,621.

The drawing of the crane hooks is a standard of the Elswick Works, Newcastle-on-Tyne, the different dimensions being given for capacities ranging from ½ ton to 21 tons.



DETAILS OF BOAT CRANE FOR UNITED STATES BATTLESHIP WISCONSIN.

The drawing and table are self-explanatory. Dimensions are in inches:

Tons	A	B	C	D	E	F	G	H
½	3 13/16	2 3/8	1 1/4	1 1/4	1	3/4	3/4	3/16
3/4	4 1/8	2 1/2	1 7/16	1 1/4	1 1/16	13/16	13/16	1/4
1	4 1/2	2 11/16	1 5/8	1 5/16	1 1/8	7/8	7/8	5/16
1 1/2	4 7/8	2 13/16	1 3/4	1 5/16	1 3/16	1	7/8	3/
2	5 1/4	3	2	1 3/8	1 1/4	1 1/16	15/16	7/16
3	5 5/8	3 1/8	2 1/8	1 3/8	1 5/16	1 1/8	1	1/2
4	5 15/16	3 5/16	2 5/16	1 7/16	1 3/8	1 3/16	1	9/16
5	6 5/16	3 7/16	2 1/2	1 1/2	1 7/16	1 1/4	1 1/16	5/8
6	6 21/32	3 5/8	2 11/16	1 5/8	1 1/2	1 3/8	1 1/8	11/16
8	7 3/8	3 15/16	3	1 5/8	1 5/8	1 1/2	1 1/8	11/16
10	8 1/8	4 1/4	3 5/16	1 3/4	1 3/4	1 5/8	1 3/8	3/4
12	8 27/32	4 9/16	3 5/8	1 7/8	1 7/8	1 13/16	1 7/16	3/4
15	9 9/16	4 7/8	3 7/8	1 15/16	2	1 15/16	1 9/16	13/16
18	10 1/4	5 3/16	4 3/16	2 1/8	2 1/8	2 1/8	1 5/8	13/16
21	11	5 1/2	4 1/2	2 1/4	2 1/4	2 1/4	1 3/4	7/8

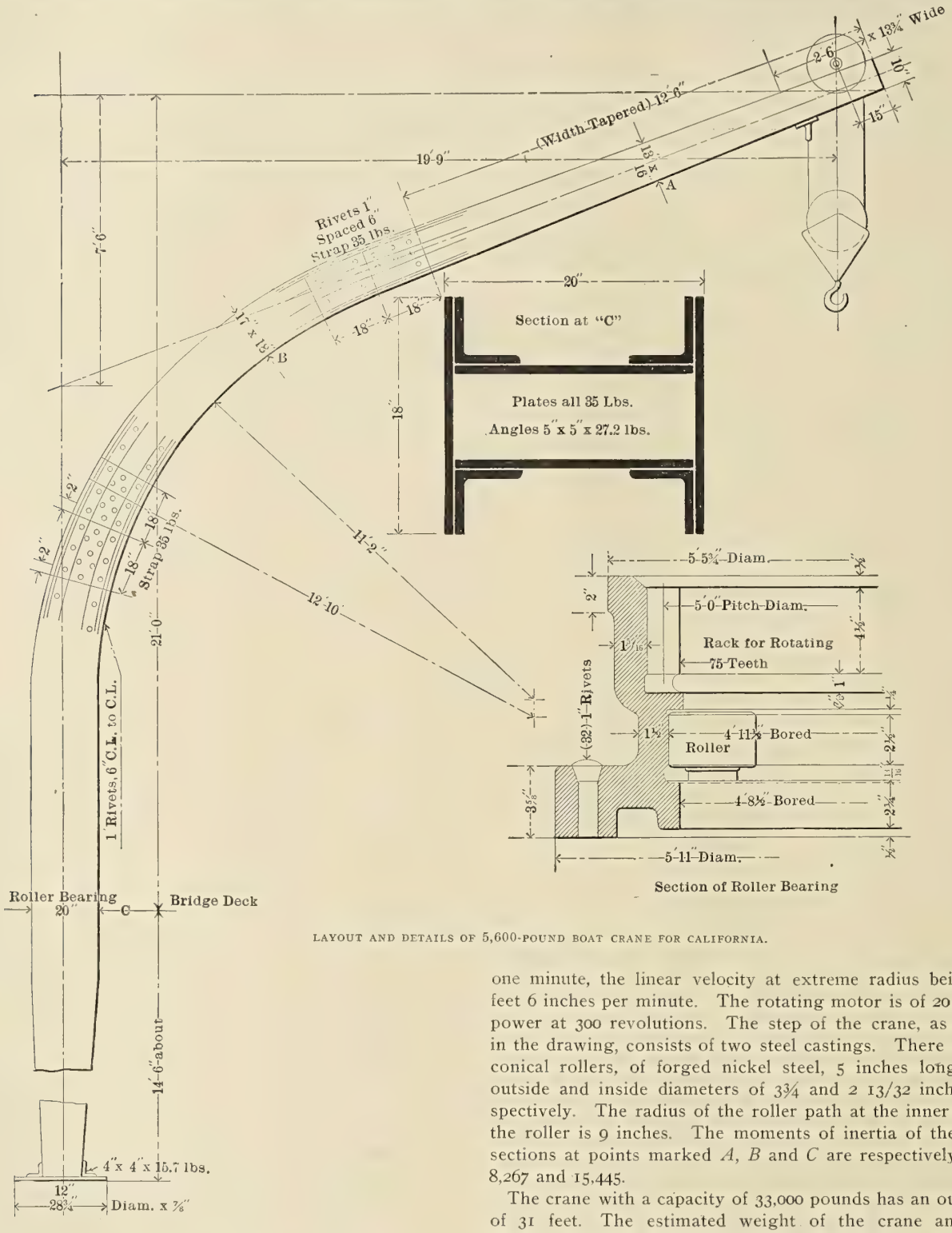
The details shown of the boat crane of the battleship *Wisconsin* are radically different from those of the cruisers. The crane itself is of a totally different design, and the radius of hoisting can be regulated at will. This crane is, as before, a built-up box girder, our drawing showing only the upper section, which is approximately horizontal on the upper face. The details and dimensions are shown so clearly in the drawings as to require little elaboration.

Drawings are shown of three cranes fitted to the armored cruiser *California*, the capacities being respectively 5,600, 17,000 and 33,000 pounds, and the test load in each instance double the capacity. These cranes are quite similar in general design, but differ markedly, of course, in detail, and particularly in dimensions.

The smallest of the three has a radial reach of 19 feet 9 inches. It is stepped at the main deck and is fitted with a roller bearing at the bridge deck, consisting of a steel casting fitted with twelve rollers, each of a diameter of 4½ inches, and a face of 2½ inches. The hoisting motor, which is of 20 horsepower, operates at 300 revolutions per minute, giving a hoisting speed of 40 feet per minute with full load, and 90 feet with the empty hook. The load on the running rope is 2,800 pounds. This rope is of galvanized steel, ⅝ inch in diameter, and is allowed a working stress of 3,420 pounds per square inch. The hoisting drum and brakes are the same as on the smaller crane previously described. The rotating motor is also the same as for the smaller crane, while the linear velocity at 19 feet 9 inches radius is 124 feet per minute. The moments of inertia of the crane sections at the points marked *A*, *B* and *C* on the drawing are respectively 1,483,

3,119 and 4,236. The step is similar to that of the next larger crane.

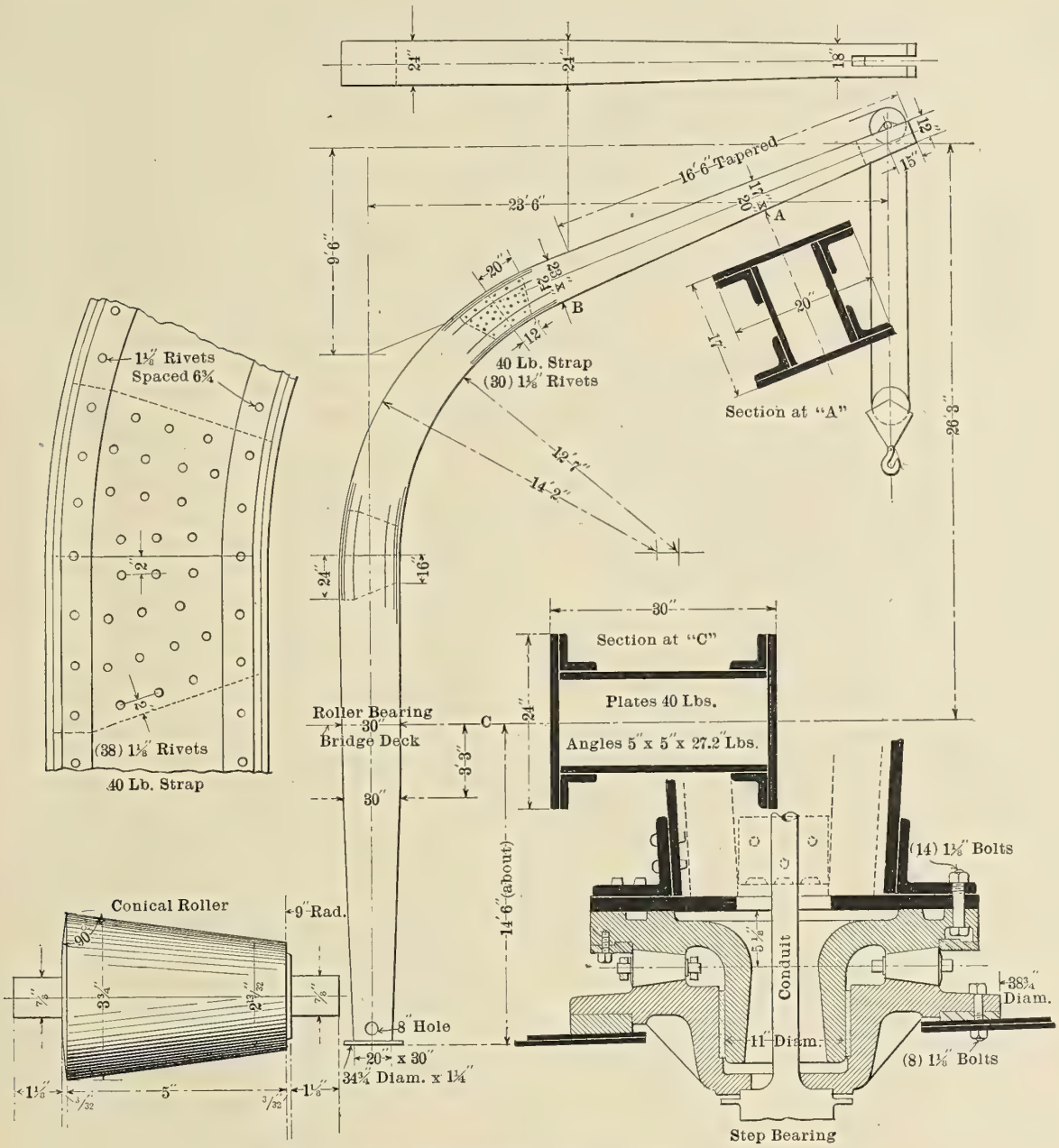
The 17,000-pound crane has a radial overhang of 23 feet 6 inches, and the estimated weight of the crane and machinery complete is 48,000 pounds. The setting of the crane is similar to the previous, the roller bearing at the bridge deck being of the same design, but larger in dimension. The twelve rollers have each a diameter of 6 inches and a face of 3 inches. The hoisting motor is of 30 horsepower at 300 revolutions per minute, and gives a hoisting speed with load of 25 feet per minute, and with the empty hook of 60 feet. The maximum load on the rope is 5,667 pounds, the running rope being of galvanized steel 13/16 inch in diameter, and figured for an allowable working stress of 5,760 pounds per square inch. The pitch diameter of the hoisting drum is 23 inches, and the circumference 72¼ inches, the revolutions being 12½ per minute, and the brakes, as before, both mechanical and electric. The crane can be revolved through an entire circle in one minute, the linear velocity at extreme radius being 147 feet 6 inches per minute. The rotating motor is of 20 horsepower at 300 revolutions. The step of the crane, as shown in the drawing, consists of two steel castings. There are ten conical rollers, of forged nickel steel, 5 inches long, with outside and inside diameters of 3¾ and 2 13/32 inches, respectively. The radius of the roller path at the inner end of the roller is 9 inches. The moments of inertia of the crane sections at points marked *A*, *B* and *C* are respectively 3,525, 8,267 and 15,445.



LAYOUT AND DETAILS OF 5,600-POUND BOAT CRANE FOR CALIFORNIA.

The crane with a capacity of 33,000 pounds has an outreach of 31 feet. The estimated weight of the crane and machinery complete is 76,000 pounds. The crane is similar in all respects to the previous one, except in size. The hoisting motor develops 50 horsepower at 350 revolutions, giving hoisting speeds as in the previous crane. The maximum load on the hoisting rope is 8,250 pounds, the running rope being of galvanized steel of a diameter of 1 inch. This rope is allowed a maximum working stress of 8,600 pounds per

square inch. The hoisting drum is fitted with brakes as before. It has a pitch diameter of 38½ inches, the circumference being 10 feet 1 inch, and it makes a little more than 10 revolutions per minute. The rotating motor is of 30 horsepower at 300 revolutions. It revolves the crane through a complete circle in two minutes, the linear velocity at a radius of 31 feet being 147 feet per minute. The roller bearing



LAYOUT AND DETAILS OF 17,000-POUND BOAT CRANE OF ARMORED CRUISER CALIFORNIA.

at the bridge deck contains sixteen rollers, each having a diameter of 8 inches and a face of 4 inches. The crane is controlled here by an electrical brake. The bearing is of the same type as for the 5,600-pound crane. The step bearing has fourteen rollers, 5½ inches long, and with inner and outer diameters of respectively 2⅔ and 3⅞ inches. These rollers operate between steel castings, as shown in the drawing, and are themselves of forged nickel steel. The moments of inertia of sections *A*, *B*, *C* and *D* are respectively 8,607, 33,915, 46,375 and 58,260. (*See page* 464.)

(*To be concluded.*)

The Strength and Stiffness of Wood.

The use of wood as a shipbuilding material has, of course, undergone a tremendous decrease in the last few decades. It is still used, however, to a considerable extent on shipboard, notably for decks, interior fittings, masts and spars, and in many other ways which will occur to the reader. When used for decks, wood contributes to some extent to the longitudinal strength and stiffness of the structure as a whole, and for this reason a bulletin issued by the Forest Service of the United States Department of Agriculture, upon the effect of duration of stress on the strength and stiffness of wood, will be interesting.

It has been established that a wooden beam, which for a short period will sustain safely a certain load, may break eventually if the load remains. For instance, wooden beams have been known to break after fifteen months under a constant load of but 60 percent of that required to break them in an ordinary short test. There is little definite and

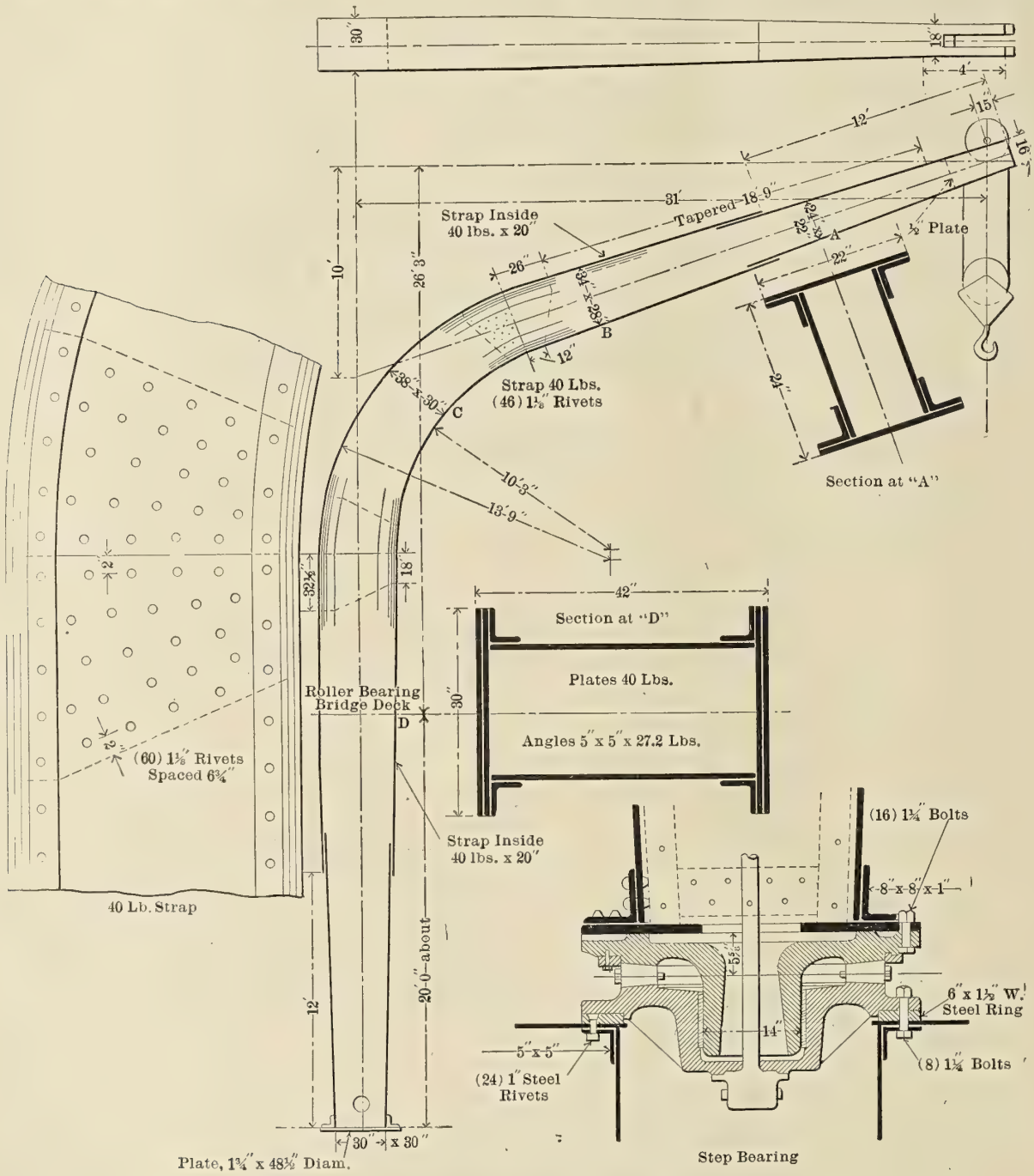
systematic knowledge of the influence of the time element on the behavior of wood under stress.

This relation of the duration of stress to the strength and stiffness of wood is now being studied by the Forest Service at its timber-testing stations at Yale and Purdue universities. The investigation should determine: (1) the effect of a constant load on strength; (2) the effect of impact load or sudden shock; (3) the effect of different speeds of the testing machine used in the ordinary tests of timber under gradually increasing load; and (4) the effect of long-continued vibration.

To determine the effect of constant load on the strength of wood, a special apparatus has been devised by which tests on a series of five beams may be carried on simultaneously. These beams are 2 by 2 inches in section and 36 inches in length, each under a different load. Their deflections and breaking points are automatically recorded upon a drum which requires 30 days for one rotation. The results of these tests, extending over long periods of time, may be compared with those on ordinary testing machines; and in this way safe constants, or "dead" loads, for certain timbers may be determined as to breaking strength or limited deflections.

The experiments show that the effects of impact and gradually applied loads are different, provided that the stress applied by either method is within the elastic limit of the piece under test. For example, a stick will bend twice as far without showing loss of elasticity under impact, or when the load is applied by a blow, as it will under the gradually increasing pressure ordinarily used in testing. These experiments are being extended to determine the general relations between strength under impact and gradual loads.

Bending and compression tests, to determine the effect of the speed of application of load on the strength and stiffness



LAYOUT AND DETAILS OF 33,000-POUND BOAT CRANE OF ARMORED CRUISER CALIFORNIA.

of wood, have already been made at the Yale laboratory. The bending tests were made at speeds of deflection varying from 2.3 inches per minute to 0.0045, and required from twenty seconds to six hours for each test. The woods used were longleaf pine, red spruce and chestnut, both soaked and kiln-dried. From the results are obtained comparable records for difference in speeds in application of load. A multiplication of the results of any test at any speed by the proper reduction factor, derived from these experiments, will give equivalent values at standard speed. The tests also show concretely the variation of strength due to variations of speed liable to occur during the test itself. The results plotted on cross-section paper give a remarkably even curve as an expression of the relation of strength to speed of application of load, and show much greater strength at the higher speeds. A numerical expression of the law, averaging all species, both wet and kiln-dry, gives the following table, which shows the increase in strength with the increase of speed of test:

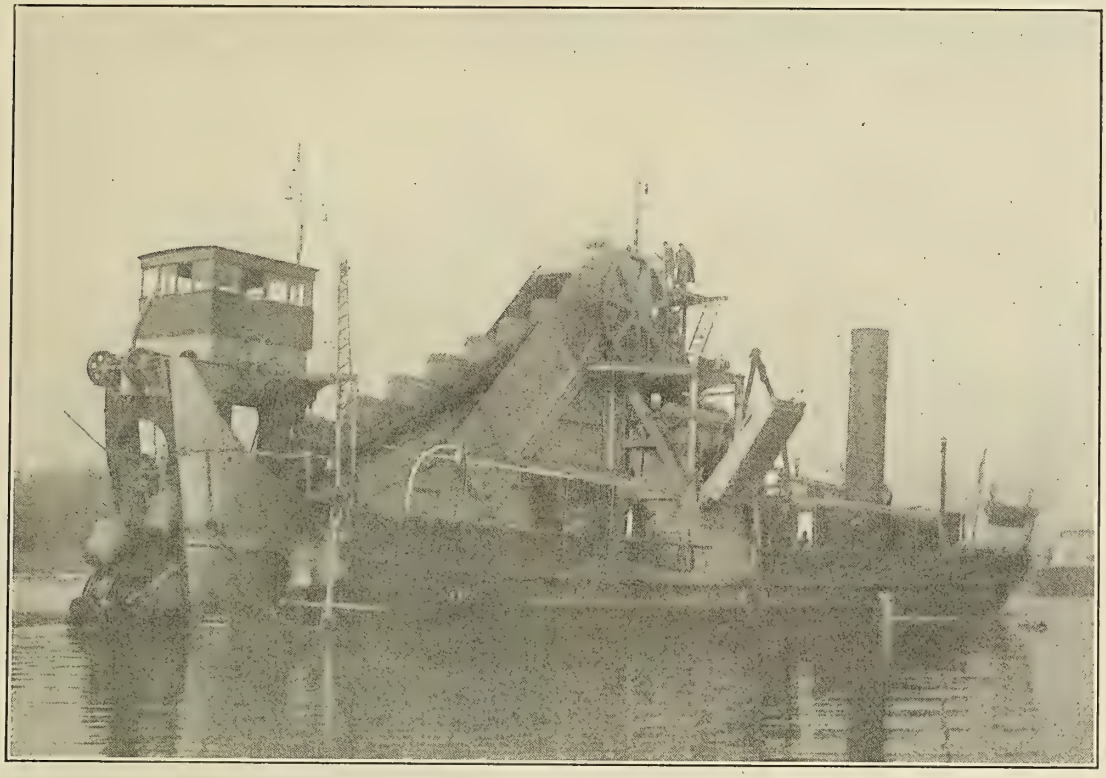
Minutes to move crosshead 1 inch.	Ratios of ultimate strength. Compression.	Bending.
900	100	100
350	100.8	100.9
150	102.3	107.3
40	106.9	110.1
5	113.8	118.7

The first column, which gives the number of minutes required to move the crosshead of the testing machine over the space of 1 inch, is the reciprocal of speed. The second and third columns give the effect of this increase of speed upon compression and bending, respectively, and show that strength increases with speed. The strength at the lowest speed is arbitrarily fixed at 100 as a convenient basis for comparison. The ordinary bending test speed for small specimens is one-tenth inch per minute, or, reciprocally, 10 minutes are required to move the crosshead 1 inch.

A Sea-Going Bucket Dredge.

BY DR. ALFRED GRADENWITZ.

The sea-going bucket dredge *Fedor Solodoff*, constructed at the Danubius-Schoenichen-Hartmann shipyards, at Budapest, is of the suction-pipe type with floating conduits. This dredge is intended for service at the mouth of the River Don and on the Sea of Azoff, where it was taken and placed in operation after undergoing some most exhaustive tests. The excavated material is conveyed by a rinsing pump to the shore through a floating conduit 500 meters (1,641 feet) in length and 600 millimeters (23.7 inches) in diameter, against a head of 6 meters (19.7 feet). This pump is further connected to a suction pipe, allowing the material to be drawn away from pontoons lying close to the dredge.



GENERAL VIEW OF THE DREDGER FEDOR SOLODOFF, FOR USE ON THE DON AND SEA OF AZOFF.

The main dimensions of the dredge are as follows:

	Meters.	Feet.
Length on deck	46.5	152.5
Length between perpendiculars	45.2	148.3
Breadth across frames	8.8	28.9
Depth	3.6	11.8
Draft in working order	2.4	7.9

The dredge is provided outside with two substantial sheer rails, consisting of iron-lined oak beams, the upper one running around the whole of the vessel, and the lower extending on both sides to three-quarters of the length of the ship. The hull has been built of Siemens-Martin ingot iron, the plating being from 7 to 9 millimeters (9/32 to 3/8 inch) in thickness. The frame angles, measuring 90 × 75 × 8 millimeters (3½ × 3 × 5/16 inches), have been reinforced by several substantial stringers and frames. The vessel is divided into eight watertight compartments by transverse bulkheads. The deck has been made of pitch pine.

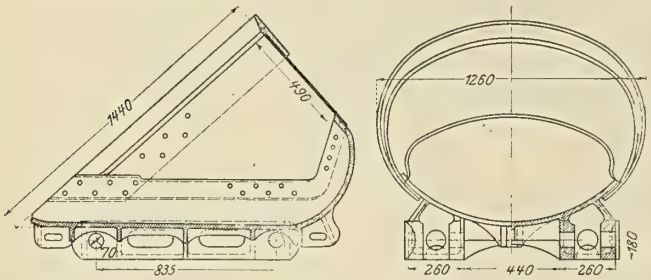
In the middle of the deck there is an office for the operating engineer, and a cabin reserved for the dredge operator. Rooms for the engine personnel and crew have been installed

on both sides of the ship below deck, the kitchen being situated on the rear deck. All the rooms have been equipped with electric light and steam heat. Besides the usual deck lighting and two 100-candle-power "position" lanterns, there have been provided two arc lamps of 1,000 candle-power each, for working by night.

The dredge has been fully equipped so as to be sea-going, and is driven by a 320-horsepower compound engine, which drives at the same time a centrifugal pump that supplies the additional water. This engine has cylinders 400 and 630 millimeters (15¾ and 24¾ inches) in diameter, with 400 millimeters piston stroke, and runs at about 140 revolutions per minute.

The steering stand, with the rudder, compass, engine telegraph, etc., is situated on the upper platform of the main trestle. These trestles are very substantial and are made of plate and profile iron, the four supports of the main trestle running through the deck down to the bottom of the ship, with which they are most securely connected, as well as with the deck, which there consists of iron. The front or ladder lifting trestle, with the dredge operator's stand thereon, bridges over the slot, constituting a very substantial connection between the two lateral parts.

Dredging is effected to a depth of 6.5 meters (21.3 feet), the dredge being so constructed as to be able to dredge itself clear, and to make its way through sandbanks by itself. The bucket ladder, which is free to rotate around the upper part of the main trestle, its lower end being suspended by heavy steel wire ropes, is lifted and lowered by means of a worm and toothed wheel gearing from a small twin steam engine fixed to the front trestle. The buckets are twenty-six in number, and have a capacity of 0.63 cubic meter (0.825 cubic yard) each. Their rear parts and bottoms are cast of steel, in one piece with the connecting links. The front part consists of steel plate, and is provided with a replaceable edge of hard steel casting. The intermediary links are of wrought steel, the bolts and boxes being designed in the usual way. The bucket chain runs on case hardened rollers, the axles of which are located in white metal boxes.



BUCKET DETAILS: DIMENSIONS IN MILLIMETERS.

A crane of 12 tons capacity has been located on the main trestle for fitting in the tumbler, and another rotary crane of 2.5 tons has been suspended on deck for mounting the buckets, while a third one, 6 tons in capacity, is situated on the front trestle, and serves for fitting in the lower winch pulleys.

The pumping engine is operated through an intermediate shaft and a toothed wheel gearing from a vertical compound engine about 250 horsepower in capacity, with surface condensation. This engine, which is supplied with a powerful governor, has the same dimensions as the propelling engine, and runs at a speed of 120 revolutions per minute.

All the toothed wheels are made of cast steel. The intermediate shaft is provided with a safety friction clutch, being automatically disengaged under excessive resistances. The upper tumbler consists of two case-hardened squares keyed to the steel shaft, and connected together by buckle plates and substantial anchor screws. The lower winch pulleys are of hexagonal shape, and are lined with substantial steel wearing plates.

The discharging tank has been fitted between the four main girders of the trestle, a balanced valve allowing the excavated material to be conveyed through either the left or the right-hand chute into pontoons, or through the reservoir fitted in the hull to the rinsing or throwing pump. The outside parts of the chutes are suspended by wire ropes, and are lifted and lowered by the aid of intermediate gearings from the warping engine.

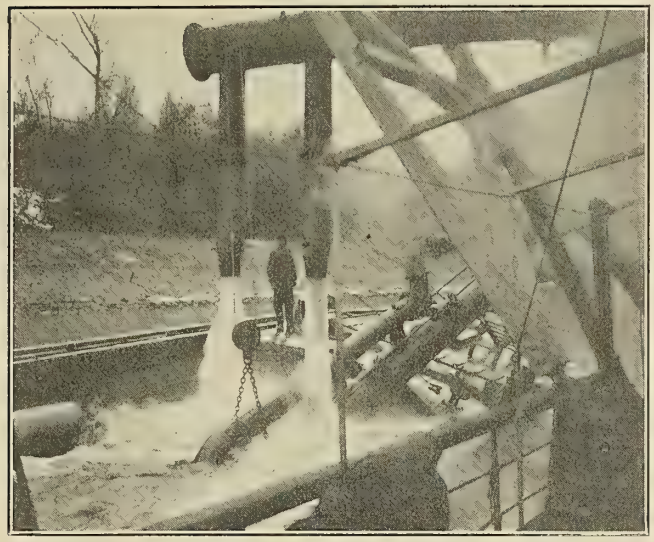
The rinsing pump is of the centrifugal type, the casing being lined inside partly with case-hardened plates and partly with hard steel plates. The gyroscope, 2 meters (6.56 feet) in diameter, is likewise made of cast steel, and has been provided with exchangeable vanes. The pump is direct connected to a compound engine with surface condensation, yielding about

DETAIL OF THE BUCKET LADDER AND GEARING.

500 indicated horsepower with 160 revolutions per minute in full working order. Its cylinders are 520 and 820 millimeters (20½ and 32¼ inches) in diameter and 450 millimeters (17¾ inches) in stroke.

The auxiliary pump is likewise of the centrifugal type, with pipes 650 millimeters (25 inches) in diameter, a gyroscope 1,450 millimeters (57 inches) in diameter, and an output of 2,500 cubic meters (3,270 cubic yards) per hour, with 160 to 170 revolutions per minute. This pump, as above mentioned, is operated by the propelling engine, and supplies the additional water for diluting the excavated material, either in the reservoir of the rinsing pump or by swinging the pressure pipe around in the pontoon to be pumped empty.

The suction pipe for pumping out the pontoon should be lowered into the material to be excavated as quickly as possible, so that the suction head may be covered with water and soil, the pump otherwise drawing in air and dropping the water. To prevent this, the suction pipe has been fitted with another additional water pipe, whence the water is thrown



THE SUCTION PIPES PUMPING OUT THE PONTOON.

THE SUCTION PIPES LEAVING THE PONTOON.

under high pressure into the material to be excavated, there producing an excavation into which the suction pipe drops. The drawing in of the rinsing pump is readily effected within about a minute by the aid of a substantial steam-head ejector. Above the pump reservoir, there has been arranged a knife grate for crushing the excavated material before its entering the rinsing pump; this grate is movable and is operated by a small steam engine. Such material or stones as are of excessive dimensions are left on the grate, whence they are readily removed.

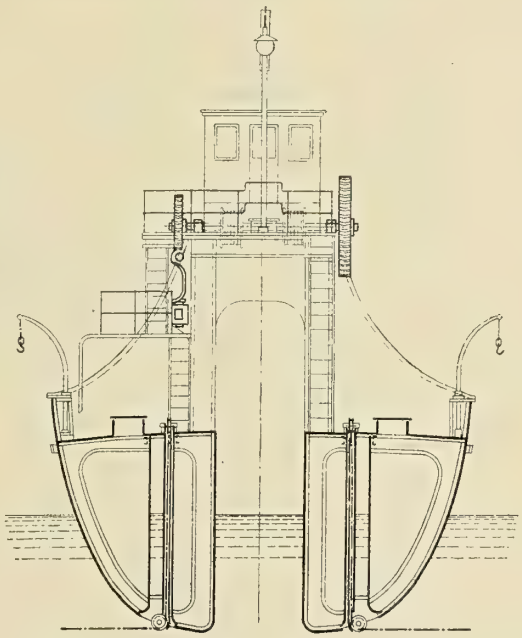
The warping engine above mentioned is a horizontal single-cylinder steam engine, operating by the aid of intermediate gearings and friction change gears. Two winches are on deck, one of which, with two chain drums, serves to effect the forward and backward motion, while the other winch, with its four drums, adjusts the dredge. The friction change gears are thrown in and out from the operator's stand by the aid of ropes, the running-out chains being conveyed into rotary-chain boxes below deck. The traffic on the river Don being rather lively, the lateral warping chains are carried at a considerable depth below water through tubes in the hull, running across rollers and rotary chain pulleys, as shown in the section. Two mechanically-driven capstans at the sides and a steam-operated winch on the stern deck of the dredge are used in readily and quickly hauling the pontoons.

Two cylindrical boilers with return tubes, having an aggregate heating surface of 260 square meters (2,800 square feet), at 8½ atmospheres (125 pounds per square inch) working pressure, readily supply the steam required for full operation. There is in addition a vertical auxiliary boiler with 12 square meters (129 square feet) heating surface, and 8½ atmospheres working pressure for steam heating and night lighting. The boilers are controlled by the engine feed pump and two injectors.

The operator's stand contains all the levers and ropes required for operating the winches, as well as a throttle valve in the steam pipe, a steam whistle and bell ropes, engine telegraphs and speaking tubes, a pointer operated from the bucket-lifting gear, which at any moment records the actual depth of dredging. The operator thus has a full inspection of the whole mechanism from his elevated stand.

In connection with the official trials carried out at the mouth of the river Don, as much as 450 cubic meters (588 cubic yards) per hour of the heavy soil was dredged with the use of only twelve buckets per minute. The dredge in normal operation, with fifteen buckets per minute, readily deals with 550 cubic meters (720 cubic yards) per hour. After lifting 350 cubic meters (458 cubic yards) of heavy soil the dredge forced this to the shore, a distance of 500 meters (1,641 feet), under a head of 6 meters (19.7 feet).

The average speed of the dredge in sailing from Sulina to Rostoff was about 7 knots, as against the stipulated speed of 5 knots. All of the above performance figures are considerably in excess of those stipulated by contracts.



CROSS SECTION THROUGH LADDER OPENING.

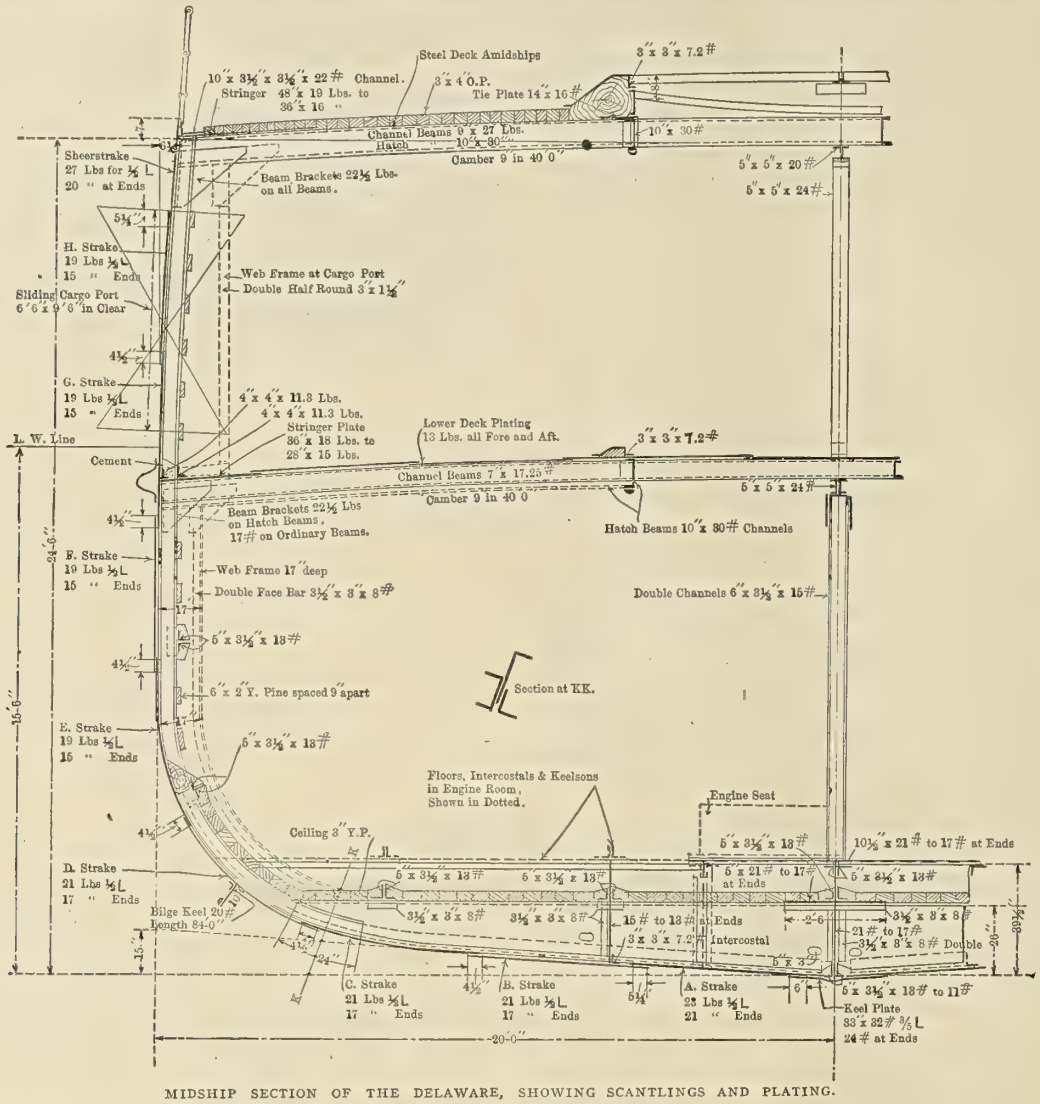
Personal.

Walter B. Snow, late and for many years publicity agent of the B. F. Sturtevant Company, has opened an office at 170 Summer street, Boston, Mass., as a publicity engineer, along the lines of machinery and allied products, including the compilation of catalogues and other forms of technical writing.

THE STEAMSHIPS DELAWARE AND PAWNEE.

BY CHARLES S. LINCH.

The latest additions to the fleet of the Clyde Steamship Company are the steamers *Delaware* and *Pawnee*. These two ships were built at the yard of the Harlan & Hollingsworth Corporation, Wilmington, Del., and are attracting a great deal of attention, due to their speed and economy. They are built under the rules of the American Bureau of Shipping, twenty-year class. Like the other ships of the fleet they are rigged as two-masted schooners, having steel-pole masts with wooden topmasts. They are equipped with all the necessary appliances for rapidity and ease in handling cargo. As both ships are identical the following description of one will apply to both:


Steel Deck Amidships
10" x 3½" x 3½" x 22# Channel.
Stringer 48" x 19 Lbs. to 36" x 16 "
3" x 4" O.P.
Tie Plate 14" x 16#
3" x 3" x 7.2#
Channel Beams 9 x 27 Lbs.
Hatch " 10"x-80"
Camber 9 in 40 0"
10" x 30#
5" x 5" x 20#
5" x 5" x 24#
Sheerstrake
27 Lbs for ½ L
20 " at Ends
Beam Brackets 22½ Lbs. on all Beams.
H. Strake
19 Lbs ½ L
15 " Ends
Web Frame at Cargo Port
Double Half Round 3" x 1½"
Sliding Cargo Port
6'6" x 9'6" in Clear
G. Strake
19 Lbs ½ L
15 " Ends
4" x 4" x 11.3 Lbs.
4 x 4" x 11.3 Lbs.
Stringer Plate
36" x 18 Lbs. to 28" x 15 Lbs.
Lower Deck Plating
13 Lbs. all Fore and Aft.
L. W. Line
Cement
Channel Beams 7" x 17.25#
Camber 9 in 40 0"
5 x 5 x 24#
Beam Brackets 22½ Lbs on Hatch Beams, 17# on Ordinary Beams.
Hatch Beams 10" x 30# Channels
F. Strake
19 Lbs ½ L
15 " Ends
Web Frame 17" deep
Double Face Bar 3½" x 3" x 8#
Double Channels 6" x 3½" x 15#
6" x 3½" x 13#
6" x 2" Y. Pine spaced 9" apart
Section at KK.
E. Strake
19 Lbs ½ L
15 " Ends
Floors, Intercostals & Keelsons in Engine Room, Shown in Dotted.
Engine Seat
Ceiling 3" Y.P.
10½" x 21# to 17# at Ends
5" x 3½" x 13#
6 x 3½ x 13#
6 x 21# to 17# at Ends
D. Strake
21 Lbs ½ L
17 " Ends
Bilge Keel 20# Length 84-0"
3½" x 3" x 8#
15# to 13#
Ends
Intercostal
21# to 17#
Double
C. Strake
21 Lbs ½ L
17 " Ends
B. Strake
21 Lbs ½ L
17 " Ends
A. Strake
23 Lbs ½ L
21 " Ends
Keel Plate
33" x 32# ⅜ L
24# at Ends
20-0"

MIDSHIP SECTION OF THE DELAWARE, SHOWING SCANTLINGS AND PLATING.

HULL.

The main dimensions are as follows:

Length between perpendiculars	255 feet 9 inches.
Length over all	267 "
Beam, molded	40 "
Depth, molded	24 " 6 "
Draft	15 " 6 "
Load displacement	2,840 tons
Block coefficient	0.65
Prismatic coefficient	0.724
Area load-water plane	8,084 square feet.
Area immersed midship section	556.8 " "
Wetted surface	13,072 " "
Tons per inch immersion at load-water plane	19.25

The various designing numerals are as follows: Depth, 25.25; half-girth, 40.67; half breadth, 20; transverse (sum of above three), 85.92; length, 250 (omitting propeller aperture); longitudinal and equipment numeral, 21,480. The ratio of length to depth is 9.9 to 1.

These ships are single bottom with two decks, the lower deck being of steel 13-pound plate, all fore and aft. The upper deck is steel amidships; the stringer, extending fore and aft from amidships, being 48 inches by 19 pounds to 36 inches by 16 pounds. The ships are built with a flat keel and keelson, the keelson extending above floors, with rider plate on top. The flat keel is 33 inches by 32 pounds for 3/5 length, reduced to 24 pounds at ends. The center keelson is 39½ inches high, 21 to 17 pounds, connected to floors, keel and rider plate by 5 by 3½-inch by 13 to 11-pound angles. The rider plate is 10½ inches by 21 to 17 pounds. The floor stringers on each side of center keelson are 15 inches by 21 to 17 pounds. The center line keelson is carried fore and aft, and is rigidly connected to the stem.

The stem is made in one piece, shaped to suit keel, and is of 9½ by 2½ inches rolled steel bar. The stern frame is a steel casting; propeller post, 49½ square inches sectional area; rudder post, 40½ square inches. The rudder is a steel casting. The stock, of steel, has a diameter of 7⅝ inches. The pintles are of wrought steel, 3½ inches diameter, and are fitted with brass sleeves, working in lignum vitæ bushings. The weight of rudder is carried by a bearing built up inside of the hull.

The frames on the sides are channels, 6 by 3½ inches by 15 pounds amidships, spaced 24 inches centers. On the bottom are angles, 4 by 3½ inches by 10.6 pounds; and at ends, angles 5 by 3 inches by 10 pounds. Reverse frames, at ends, are 3½ by 3-inch by 8-pound angles; under boilers and engine, 3½ by 3-inch by 8-pound double angles. The floors are 26 inches deep by 20 pounds amidships, flanged on top 3½ inches. Under the engine they are 39½ inches deep by 23 pounds, bracketed to frames. Under boilers the floors are 26 inches deep by 23 pounds.

There are four keelsons on each side in lower hold. The side keelsons are of 15-pound plate, fitted intercostal between frames, and fastened to shell with 3 by 3-inch by 7.2-pound angles, and double 5 by 3½-inch by 13 to 11-pound angles on top of floor. The upper and lower keelsons have two 5 by 3½-inch by 13 to 11-pound angles back to back.

The shell plating is of the raised and sunken type, with butts lapped, and solid liners at frames in wake of outside strake. The garboard strake is 23 pounds for ½ length and 21 pounds at ends. The bottom plating is 21 pounds for ½ length, reduced to 17 pounds at ends. The bilge and side plating is 19 pounds for ½ length, reduced to 15 pounds. The main sheer strake is 27 pounds for ½ length, reduced to 20 pounds. Double plates are fitted forward for protection against damage by anchors, etc. The main deck beams are 9-inch by 27-pound channels; hatch beams, 10 inches by 30 pounds. Lower deck beams are 7-inch by 17.25-pound channels. Stanchions are fitted from keelson to lower hold beams, made up of 6 by 3½-inch by 15-pound double channels. The stanchions from lower deck to main deck beams are of 5 by 5-inch by 24-pound double channels.

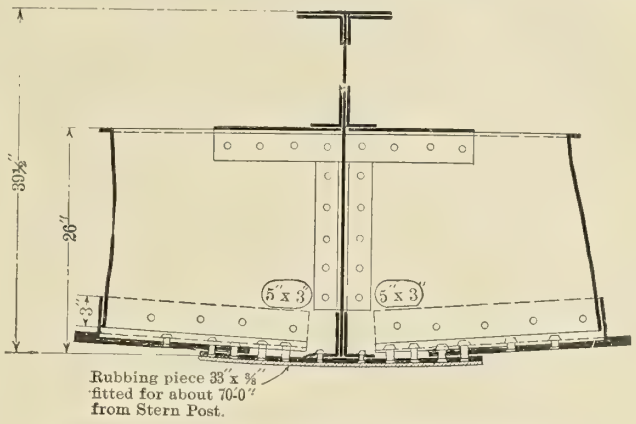
Bilge keels are fitted for a length of 84 feet, made up of 10-inch by 20-pound plate, having 2 by 1-inch half-round riveted to edge. The keels are secured to hull by 5 by 3-inch tees.

The hold is laid with 3-inch yellow pine ceiling to upper turn of bilge. Cargo battens of 6 by 1½-inch yellow pine are also fitted. The main deck is laid with 3 by 4-inch Oregon pine.

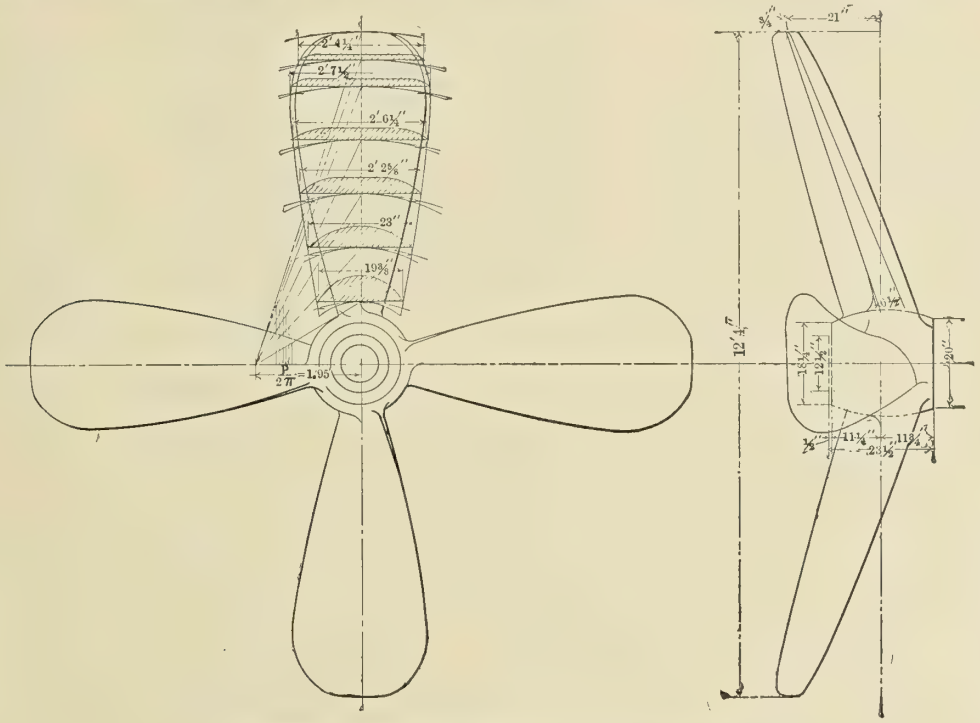
The hull is divided into five watertight compartments, by four athwartship watertight bulkheads, one at the fore peak, one at the forward end of the boiler room, one at the after end of engine room, and one at the after peak. There is a screen bulkhead between engine and boiler rooms. The shaft alley is built of 12-pound plates, amply stiffened by 3½ by 3-inch by 8-pound angles. There are two fresh-water tanks.

The masts are 63 feet and 65 feet, respectively, above the deck. There are four cargo ports of the usual type for coastwise steamers, which are 6 feet 6 inches by 9 feet 6 inches in the clear. The two cargo hatches on main deck are 16 by 12 feet; those on lower deck being two of 12 by 14 feet, and two blind hatches of 12 by 8 feet and 8 by 13 feet, respectively. These ships are equipped with windlass outfit by the American Ship Windlass Company, Providence, R. I.; four Williamson double-drum, double-eye hoisters; one Williamson steam steering engine. All quarters for officers are finished in cypress; the firemen's and sailors' quarters being on main deck.

The equipment includes three stockless bower anchors, two of 3,600 pounds each, and one of 3,060 pounds. In addition, there are a stream anchor of 1,200 pounds and a 600-pound kedge. There are 255 fathoms of chain cable and 270 fathoms of hawsers and steel wire towline.



DETAIL OF THE KEEL AND CENTER KEELSON CONNECTIONS.



THE GENERAL LAYOUT OF THE PROPELLER OF THE DELAWARE.

PROPELLING MACHINERY.

Each ship is propelled by one main engine of the three-cylinder vertical inverted direct-acting triple-expansion type, with cylinders 19, 30 and 50 inches in diameter and a stroke of 30 inches. The order of the cylinders beginning forward is: high-pressure, intermediate and low-pressure. The three cylinders are separate castings, being securely bolted together, with receivers formed by rectangular casings around the cylinder barrels. The cylinders are supported in front on finished steel columns, and have the ordinary housing of box section in back. These housings are securely bolted to flanges cast on the condenser which forms part of the engine framing.

The main valves for high and intermediate-pressure are of the single-ported piston type, one of 9½ inches diameter for high-pressure and two of the same size for intermediate. The low-pressure has a double-ported slide valve, measuring 49 by 31 7/16 inches. The valve gear is of the double-bar Stephenson link sliding block type. The high-pressure valve stem connects direct to its link block. The two stems of the intermediate pressure valves are secured to a cross-head, which in turn is connected to its link block. The low-pressure valve is fitted with a balance piston 8 inches in diameter. The main steam pipe has a diameter of 5½ inches.

The bed-plate is of deep box section, cast iron, in one piece, and has six main bearings. The main bearing boxes are of cast iron lined with white metal, and are arranged for water circulation. The bearings are 9 inches long for high-pressure, 10½ inches for intermediate, and 11 inches long for low-pressure. The thrust shoes are cast iron, lined with Parsons' white brass. The whole thrust block is provided with water circulation. The engine is fitted with complete water and oil service.

The condenser is of rectangular section, well ribbed and securely bolted to bed-plate, of which it forms a part. It contains 796 tubes, ¾ inch in diameter, with an effective length of 12 feet 2 inches, and an overall length of 12 feet 4 inches. The cooling surface is 1,900 square feet. An auxiliary condenser of 600 square feet cooling surface, with combined air and circulating pump, is provided. The pump dimensions are 7 by 10 by 10 by 12 inches.

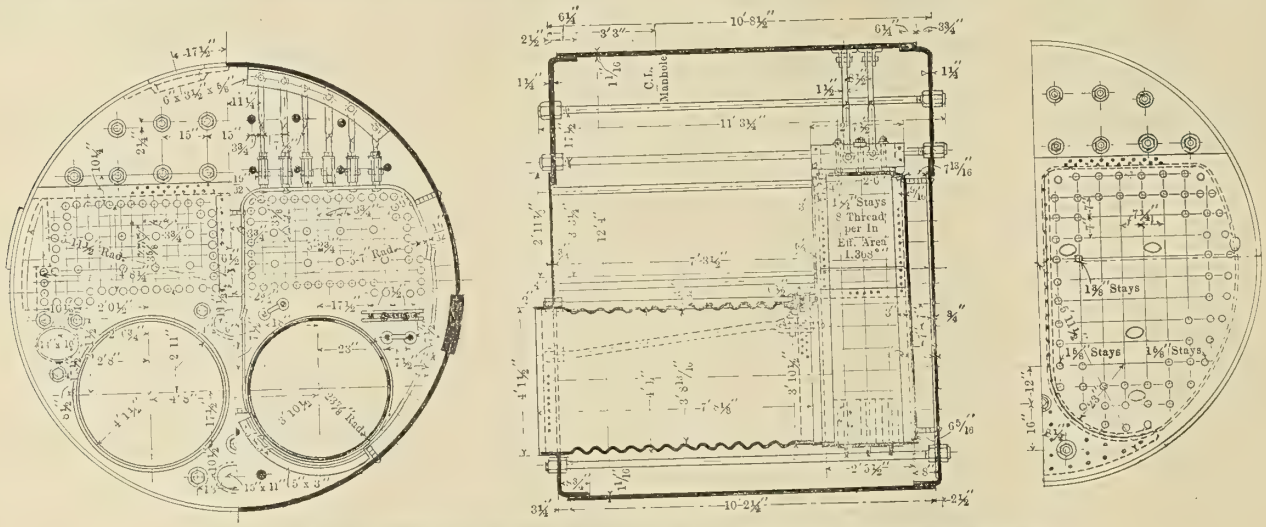
The air, feed, bilge and sanitary pumps are driven direct from intermediate-pressure cross-head, through the medium of links in the ordinary manner. The high-pressure piston is fitted with a tail rod. The guides are of the all-around type, having large surface, and are cast hollow for water circulation. The cross-head is a steel block, 7 by 7 inches, having cast iron slippers lined with white metal front and back. The slippers are 10 inches long, with 10 inches width of bearing surface.

The piston and cross-head are secured to piston rod through taper ends with nuts. The reversing gear is handled by a reversing engine, having a bore of 10 inches and stroke of 17 inches. The cut-off is adjustable by sliding cross-heads in reverse shaft arms. The piston rods have a diameter of 4¼ inches; the high-pressure tail rod of 3¼ inches. The connecting rods are 4¼ inches in diameter at the neck and 5¼ inches at the root, with a length between centers of 5 feet 7½ inches.

The crank shaft and crank pin have a diameter of 9½ inches, the pin being 9½ inches long between cheeks. The webs are 9¾ inches wide, with thicknesses of 6, 6½ and 7½ inches for the high-pressure, intermediate and low-pressure cranks. The thrust shaft, which has a length of 10 feet 11 inches, is 9¼ inches in diameter through the thrust bearing and 9 inches at the ends. There are six collars, 16½ inches in diameter and 1½ inches thick, with a space of 4½ inches between collars. The line shaft has a diameter of 9 inches, increased to 10¼ inches for the propeller shaft. All couplings are 19¼ inches in diameter and 3 inches thick.

The principal pumps have the following data, all expressed in inches:

	Diameter.	Stroke.
Air pump	20	12
Feed pump	3½	12
Bilge and sanitary pump	3	12
Circulating pump engine	6	8



THE TWO SINGLE-ENDED SCOTCH BOILERS ARE FITTED EACH WITH TWO CORRUGATED FURNACES.

The circulating pump is of the centrifugal type, with a runner 28 inches in diameter. The various suction and discharge pipes have the following diameters in inches:

Circulating pump, suction from bilge	8¼
Circulating pump, suction from sea	10¾
Circulating pump, discharge to condenser	10¾*
Donkey pump, discharge to condenser	4¾*
Air pump, discharge to filter tank	5¼*
Bilge pump suction	2¼

All other pumps are of Warren make, and comprise the following: One 4½ by 2¾ by 4-inch sanitary; one 7½ by 5 by 8-inch auxiliary feed pump; one 12 by 8¼ by 10-inch donkey. A feed-water heater with by-pass is fitted in the main feed line.

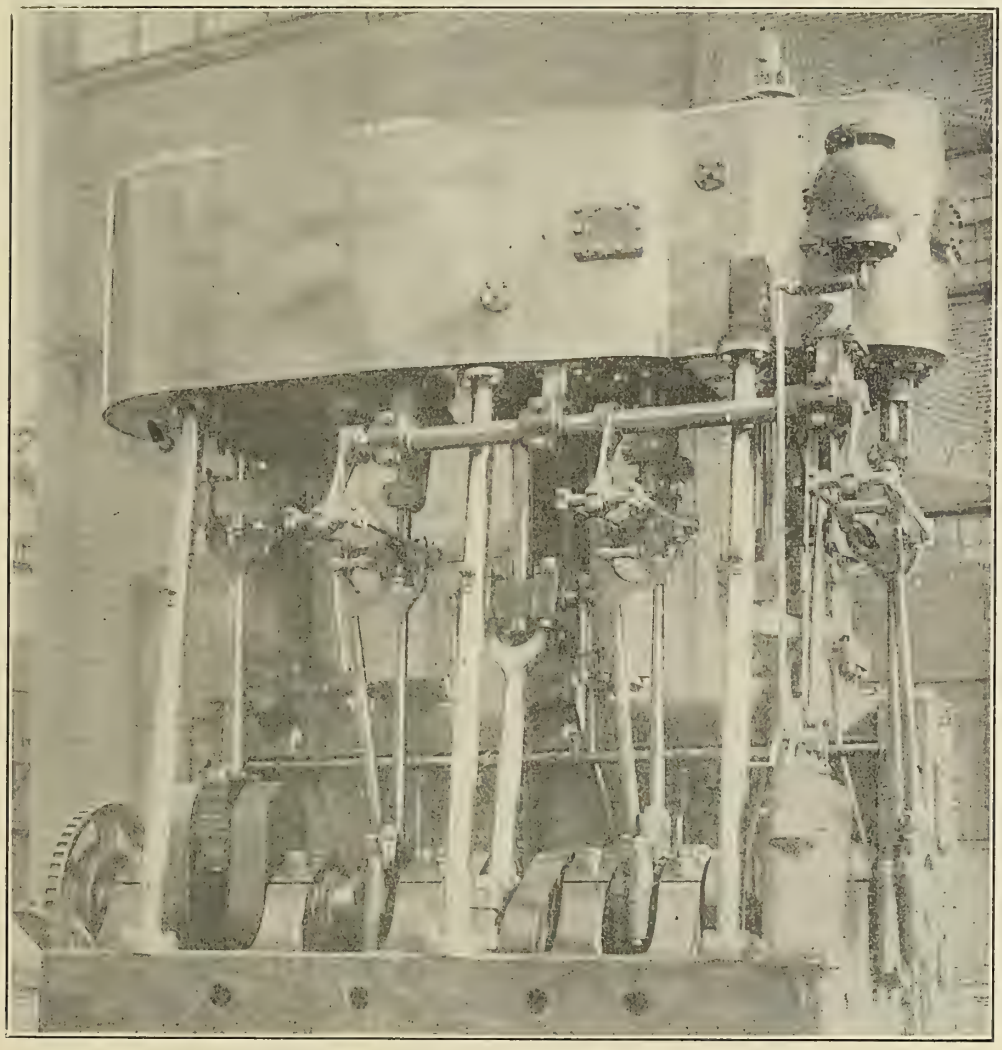
BOILERS.

The steam generating plant consists of two single-ended Scotch boilers, designed for a working steam pressure of 175 pounds per square inch gage. There is one smoke-pipe, having a diameter of 4 feet 6 inches and a height of 50 feet above

* Discharge overboard has same diameter.

grates. There is provided a system of forced draft, designed by the Harlan & Hollingsworth Corporation. The principal dimensions of the boilers are; Diameter, inside, 12 feet 4 inches; length, 10 feet 8 inches; thickness of shell, 1 1/16 inches; shell rivets, 1⅛ inches; rivet percentage of strength, 95.5; plate is 81.7 percent.

Each boiler is fitted with two 45-inch Morison suspension furnaces, 7 feet 8⅛ inches long, each having its own combustion chamber. There are 280 2½-inch tubes in each boiler, made up as follows: Fifty wrought iron stay-tubes, No. 5 B. W. G.; 230 wrought iron ordinary tubes, No. 9 B. W. G.



THE ENGINE OF THE CLYDE LINE STEAMSHIP DELAWARE.

Each boiler has seventeen through stays 2⅝ inches diameter; eight 2½-inch stays from front head to front wall of combustion chamber, and twenty-four double refined iron suspension stays, 1½ by 2 inches. The grate surface in each boiler is 43.12 square feet; heating surface, 1,651.6 square feet; with a ratio of heating surface to grate surface of 38.2 to 1. The area through tubes, 1,031 square inches, is equal to 25 square inches per square foot of grate, or a ratio of 1 to 5.76. The heating surface is made up as follows:

	Square Feet.
Two hundred and eighty 2½-inch tubes...	1,316
Furnaces	103.7
Combustion chamber	205.7
Front tube plate.....	26.2
Each boiler	1,651.6

The ratio of grate surface to cross-section of smoke-pipe is 5.42, being 2 × 43.12 ÷ 15.904. The designed evaporation of water is 240 pounds per square foot of grate per hour. Each boiler has one safety valve, 4½ inches in diameter.

PROPELLER.

The one propeller is a right-hand true screw with four blades. It has a diameter of 12 feet 4 inches, with a hub of 1.93 feet diameter. The pitch as designed was 12.3 feet; as cast it measures 12.25 feet. The helicoidal area is 44.76 square feet; projected area, 38.4 square feet; and disk area, 118.82 square feet. The ratio of helicoidal area to disk area is 0.376; of projected area to disk area, 0.323, and of projected area to helicoidal area, 0.857. The blade factor is 0.96, and thrust factor, 1.04.

An analysis of the results of the trials of these two ships will appear in December.

Foreign Commerce of the United States.

During twelve months ending with December 31, 1906, the imports of the United States were the largest on record, aggregating no less than $1,320,609,250 (£271,367,358). During the same year the exports of domestic merchandise amounted to $1,772,720,530 (£364,270,118), which figure was increased by re-exports of foreign imports to $1,798,247,943 (£369,515,657). This, again, is the largest on record. The total foreign trade is thus seen to have been $3,118,857,193 (£640,883,015) as compared with $2,806,135,345 (£576,622,900) for the year 1905, and $2,487,227,930 (£511,091,735) for

the year 1904. This tremendous commerce is carried on almost entirely by sea. The total imports carried across the border from Canada and Mexico amounted to $92,881,113 (£19,085,814); while the exports carried across the borders in a similar manner amounted to $205,504,909 (£42,228,482). This leaves a total of $1,227,728,137 (£252,281,544) imported in ships, and $1,592,743,034 (£327,287,175) exported in ships.

Of the imports, American steam and sailing vessels carried a total of $173,005,020 (£35,550,194), or 14.1 percent. Of the total exports, American steam and sailing vessels carried a total of $140,806,475 (£28,933,828), or 8.8 percent. All of the tremendous remainder, $2,506,659,676 (£515,084,697), was carried in vessels owned by foreigners, more than one-half of the grand total (51 percent) being carried in British ships, while German ships accounted for about 12⅓ percent of the aggregate. This compares with a total of 11.1 percent for vessels flying the flag of the United States.

The total tonnage movement in the foreign trade amounted to 35,642,398 tons entered, and 34,986,842 tons cleared; as compared with 32,521,236 and 32,343,072 tons, respectively, for 1905.

The National Motor Boat and Engine Shows.

There will be in the United States this winter three motor boat and engine shows under the auspices of the National Association of Engine and Boat Manufacturers, the American Association of Engine and Boat Manufacturers, and the New England Engine and Boat Association. It is stated that these three shows are the only ones recognized and supported by the three associations mentioned.

The show in New York will take place at the Grand Central Palace, December 7 to 14, inclusive, and will be the first great motor-boat show strictly divorced from the minor and sporting features. The plan calls for 143 separate booths, or exhibits, varying in size from 16 by 40 feet to as small as 7 by 10 feet, and scattered all over the main floor of the great building.

The Chicago show will be held at the Coliseum from January 1 to 8, inclusive. The plan for this show indicates a total of 197 booths, varying in size from 14 by 25 feet down to 8 by 10 feet.

The Boston show will be held in the Mechanics' Building, from January 25 to February 1, inclusive, and covers three floors. The plan shows a total of 213 booths, varying in size from 15 by 34 feet to 7 by 12 feet.

Motor Boats in Central America.

The use of gasoline (petrol) engines in motor boats in British Honduras is increasing rapidly. The first boat of the sort was installed in 1903, and was 25 feet long. It was successfully used in smooth water for towing logs and for other purposes. In 1906 there were about thirty boats afloat and building, and the number appeared to be rapidly increasing. The engines have been almost entirely of American manufacture, and are said to have given splendid satisfaction.

With no railroad, and with less than forty miles of wagon road, in the colony, freight charges to the interior settlements have been very high. The coast line is 200 miles long, and traffic has been handled by sailing sloops and schooners. For the many towns and villages upon the rivers reliance has been placed upon rowing, the service being very expensive, uncertain and, during certain seasons of the year, completely at a standstill. Motor boats are now taking up this work, and the stretch of 140 miles from Belize to The Cayo, which formerly required six days, now takes only thirty-six hours. A 48-foot 22-horsepower light-draft boat was started on this route in June of 1906, and competition has resulted in very materially lowering all freight and passenger charges. A twin-screw gasoline-propelled vessel of American build has been substituted for the coast steamers connecting Belize and Corozal, and indications point to a steady and increasing use of this form of propulsion.

Society of Naval Architects and Marine Engineers.

The fifteenth general meeting of the Society of Naval Architects and Marine Engineers will be held in assembly room No. 5, Engineering Societies building, November 21 and 22, 1907. A list of the papers to be read during the meeting is given:

1.—*An Experimental Investigation of Stream Lines Around Ships.* By Naval Constructor D. W. Taylor, U. S. N.

2.—*Some Experiments Upon the Effect of Longitudinal Distribution of Displacement.* By Professor H. C. Sadler.

3.—*Further Tactical Considerations of Warship Design.* By Commander A. P. Niblack, U. S. N.

4.—*Some Notes on Submarine Torpedo Boats.* By Mason S. Chace.

5.—*Motor Boats for Naval Service.* By Naval Constructor L. S. Adams, U. S. N.

6.—*High Speed Pleasure Motor Boats.* By H. R. Sutphen.

7.—*Motor Propelled Vessels and Notes on the Bermuda Race.* By W. B. Stearns.

8.—*Two New Revenue Cutters for Special Purposes.* By Captain C. A. McAllister, U. S. R. C. S.

9.—*Wooden Sailing Vessels (with particular reference to those built previous to the Civil War).* By B. B. Crowninshield.

10.— ——— ——— ———. By J. W. Powell.

11.—*Two Instances of Unusual Repairs.* By Asst. Naval Constructor W. B. Ferguson, U. S. N.

12.—*Tests of a New Smoke Combustion System.* By H. H. Thayer, Jr.

13.—*The Transportation of Refrigerated Meat to Panama.* By Roland Allwork.

14.—*Some Early History Regarding the Double Turreted Monitors of the Miantonomoh Class.* By W. T. Powell.

15.—*Trials of the Governor Cobb.* By Professor W. S. Leland.

16.—*Appliances for Manipulating Life Boats on Sea Going Vessels.* By Axel Welin.

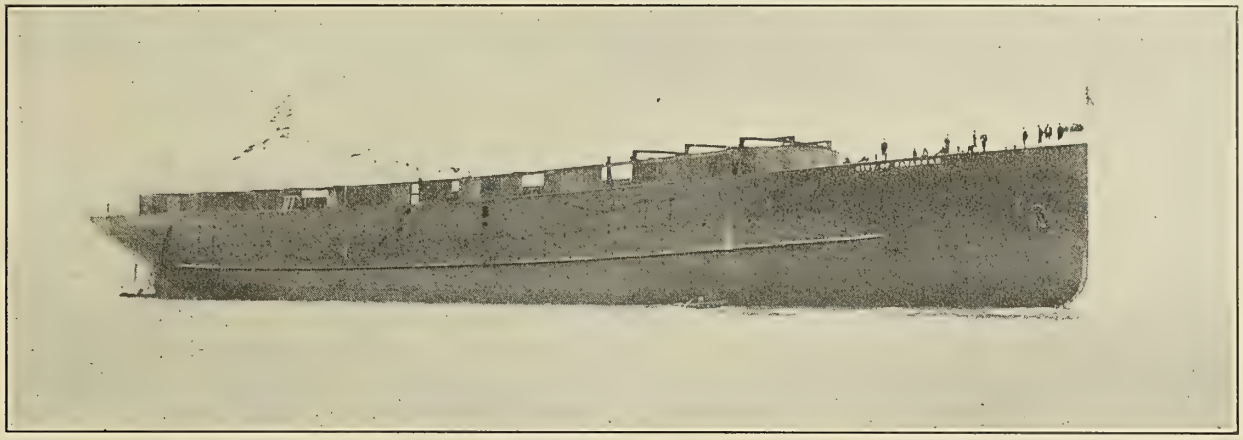
Attention should be directed to the unusual diversity of subjects. They can scarcely be grouped under four or five general headings, as has heretofore often been the case. The discussions should bring out much that is of great interest and value.

Motor Boat Fishing.

The United States consul at Stavanger, Iceland, reports that a complete revolution of the fisheries of Iceland is impending. Both the open boats and the sailing cutters show a tendency to disappear as fast as they are worn out, and no new vessels of this type are being built. In the future it is expected that the fishing will be done almost exclusively with motor boats and steam trawlers, which give a much better service and with a smaller crew. During the last two or three seasons nearly $250,000 (£50,000) has been expended for motor boats, and the results have been so excellent that instances are on record where a boat, in the course of five months, has earned double its cost, in addition to giving the master and crew an income equal to what they had formerly been accustomed to receiving in an entire year. At Westmanna Islands there were only two motor boats in

1905, but these gave such good service that thirteen new ones have recently been purchased at a cost of about $25,000 (£5,000).

Still better results have been achieved by the trawlers. A small vessel of this type, owned by a company in Havnefjord, earned in 1906 such enormous profits that two new trawling companies have been organized in Reykjavik, one of which is having a trawler built in England, while the other, which has a capital of 100,000 kroners ($26,800 or £5,500), is buying one already built in England. It is anticipated that the purchase of new trawlers will in the near future increase so rapidly as to furnish in the course of five or ten years a good-sized Icelandic trawling fleet. The main hindrance at the present is in the lack of local capital, but as the people learn to join their fortunes in companies, this will rapidly disappear.



THE NEW STEAMER CITY OF SAVANNAH AFLOAT IN THE DELAWARE RIVER AFTER LAUNCHING.

The New Steamship City of Savannah.

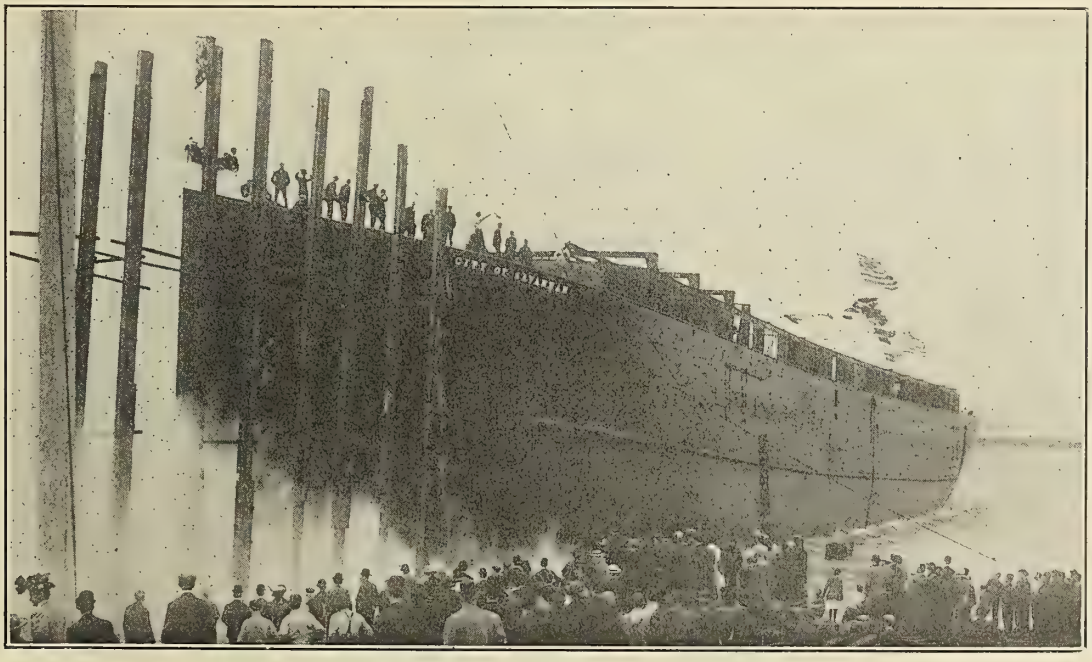
The Ocean Steamship Company (Savannah Line) was organized in 1874, and to-day the fleet running between New York and Savannah is composed of the following modern steel steamships: *City of Savannah, City of Atlanta, City of Columbus, City of Macon* and *City of Memphis,* each of which has a carrying capacity of 12,000 bales of cotton. Some idea as to their size may be had when it is known that any one of these ships could carry the combined cargoes of the entire fleet of the company as it existed in 1874.

The latest addition to the fleet is the *City of Savannah,* which was placed in service on Oct. 8, on which day she started on her maiden voyage to Savannah.

The dimensions are: Length, 403 feet 3½ inches; breadth, 49 feet; depth to hurricane deck, 35 feet; depth to main (or spar) deck, 24 feet 4 inches; freight cargo capacity, 5,900 tons; gross tonnage, 5,654.

There are 58 first cabin staterooms, accommodating 116 passengers; 12 intermediate staterooms for 36 passengers, and steerage accommodations for 60 passengers. The ship is luxuriously fitted for passenger accommodation, there being two large rooms, with large double bed, sofa, writing desk and easy chairs, also a number of other rooms, with Pullman upper berths, arranged en suite with private bath, hot and cold, fresh and salt water.

The ship was built by the Delaware River Iron Shipbuilding & Engine Works, Chester, Pa., and is scheduled to make the run from pier to pier in two days and fifteen hours.



THE STEAMER CITY OF SAVANNAH AT THE MOMENT OF LAUNCHING.

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Society of Naval Architects and Marine Engineers.

The papers to be read in November before this society are very divergent in scope and very important in character. In two cases the papers are derived from experimental investigations in model tanks, these being respectively an investigation of the stream lines around a ship in motion, and an investigation upon the effect of longitudinal distribution of displacement. Both of these papers should bring out a splendid discussion, and they will unquestionably be of much importance as an addition to our literature upon the subject of naval architecture.

The subject of motor boats is taken up in three papers, and from three different points of view. One paper discusses these vessels with regard to their adaptability to naval service, and as such will follow a similar paper presented last year. The second motor boat paper discusses high-speed boats, and deals, therefore, with the questions of powerful engines, long and easy lines and light scantlings, the latter involving a consideration of high tensile structural materials. The third paper takes up the subject of the healthy type of motor boat designed with adequate power for a good speed at sea, but designed also for habitability under all atmospheric conditions, and for an endurance of several hundred miles in open water. These three divergent types of boats discussed in the three papers make a splendid résumé of the entire subject of motor boats and their propulsion, and will certainly call forth very much discussion in the meeting.

Two of the papers are historical in character, one dealing with wooden sailing vessels of a period half a century past, and the other dealing with some of the earliest armored vessels in the United States Navy. The remaining papers are so scattered, with regard to the character of their contents, as to make it impossible to give them any general classification. There are papers on submarine boats; revenue cutters; tactical considerations of warship design; smoke combustion; marine refrigeration; lifeboat manipulation; naval repairs, and last, but not least, the trial trip of a turbine-propelled steamer operating in the coastwise traffic of the United States.

The entire list of papers is such as to be of interest and value, and most of them, coming as they do from men whose standing in the profession is very high, will give us much to think about, when they appear in print.

A New Queen of the Seas.

In our issue for October we made the by no means hazardous prediction that as soon as her machinery became a little more used to its work, the *Lusitania* would lower the Transatlantic record. As a matter of fact her first trip, which was made in five days and 54 minutes, was the shortest in point of time of any similar trip which had ever been made. The distance which she covered, however, was 200 miles shorter than that made by the *Deutschland* in five days, 7 hours and 39 minutes, and was 300 miles shorter than that made by the *Kaiser Wilhelm II* in five days, 11 hours and 58 minutes. The average speed of the *Lusitania* on her first run figures out at 23.01 knots, as compared with 23.51 for the *Deutschland* on her trip above mentioned, and 23.58 for the *Kaiser Wilhelm II*. The best run for a single day on the first trip of the *Lusitania* was 593 nautical miles, as compared with 564 in the run of the *Kaiser Wilhelm II* above mentioned, and 549 for the *Deutschland*. On another trip, however, this last mentioned ship made 601 nautical miles, which, until the present month of October, was the world's record.

The second trip of the *Lusitania*, ending early on the morning of October 11, is the first one in which any ship has reached New York from Great Britain, or from any other part of Europe, in less than five days; the time from Daunt's Rock, off Queenstown, to the Sandy Hook lightship, being four days, 19 hours and 52 minutes. As the distance was 2,780 nautical miles, the average speed was 23.99 knots, which is seen to be a new record for the passage, eclipsing that of the

Kaiser Wilhelm II by 0.41 knot, and that of the *Deutschland* by 0.48 knot. Not only was the record for the entire passage broken, but the record for a single day's run was broken twice, the second and third day's runs having been respectively 608 and 617 nautical miles. These were respectively at the rate of 24.32 and 24.68 knots, assuming the length of the day, including time difference, to be exactly 25 hours.

Under the conditions of the contract between the Cunard Line and the British Government, the *Lusitania* and *Mauretania* are required to make each year a certain number of voyages at an average speed of 24½ knots. It seems very probable that no difficulty will be experienced in this regard, after the ship has had a little more time to settle down to her regular, steady work. It will be recalled that on a 48-hour trial trip, in which she circumnavigated Ireland, a speed of more than 25 knots was maintained. If this can be done for 48 hours, it can be done, with very little diminution of average speed, for twice that length of time, and this would result in a record far better than has been the case up to date. A 25-knot trip, between the two points mentioned above where measurements are taken, would give a passage in four days, 15 hours and 12 minutes, which is 4 hours and 40 minutes better than the present record. A trip at the exact contract speed, and for the same route as that followed on the present trip, would require four days, 17 hours and 4 minutes, which again is 2 hours and 48 minutes better than the present record.

Much discussion has been aroused by this ship, and some enthusiasts aver that she will eventually make a passage in four days. To show the absurdity of such an expectation, it is necessary merely to point out that this represents an average speed across the Atlantic of 28.96 knots, a speed which has not been approached by any vessel except of the torpedo boat type, and which is more than 3 knots in excess of the trial trip record of this ship. Those who are figuring on a trip in four days and 12 hours may possibly live to see their expectations verified, for this represents an average of but 25.74 knots. Even this figure, however, is very doubtful for this ship or her sister, although it is possible that it may ultimately be reached by the one or the other.

The Launching of Ships.

One of the most critical periods in the life of a ship is comprised within the few seconds required for her to cut loose from the ways on which she has been built, and assume her natural and pre-ordained position, floating in the water. This period is one to which shipbuilders look forward always with a certain amount of apprehension, not only because of the possibilities of accident of some sort which might mar the launching, but also because there is here some little opportunity for straining the structure of a ship in such a way as to cause very serious damage.

Elaborate calculations are always entered into, in order to determine the various requirements such as the declivity of the launching ways, pressure of the ship upon each square foot of these ways, the proper size and position of the forward and after poppets forming the cradle which keeps the ship upright during the few seconds comprised within the period above mentioned, and various other features. Not the least important of these calculations is that which deals with the ability of the ship's forefoot to sustain the strain imposed upon it at what is known as the pivoting point; that is, the point at which the after poppet leaves the ways, and the ship begins to be water-borne. At this point the entire structure revolves about the forefoot as a pivot, the after portion being buoyed up by the water to a greater and greater degree as the ship progresses down the ways, while the pressure upon the forefoot increases correspondingly during this period, until finally the buoyancy becomes sufficiently great to begin to relieve this pressure, and the ship is afloat.

A recent launching witnessed by the writer went off beautifully, but there was a slight accident which might well have been magnified into a much greater one, and to which attention ought to be called. A hammer-head traveling crane, operating upon a trestle work of steel, was used to place material for the ship in question, and also for the ship in the next berth. The ship which was launched was of very great beam, and the clearance between a rubbing strip on her side and the supports of the large crane in question was none too ample. It chanced that as the buoyancy of the water began to support the after end of the ship, the tide swung this end around to such an extent as to bring the rubbing strip into direct and somewhat violent contact with the supports of the crane. One of the vertical members of the latter was bent by the rubbing contact, which extended over a distance of apparently 30 or 40 feet on the steamer. Beyond the slight bending given to this vertical member no harm resulted, but it might be pertinent to inquire what would have happened to the crowd beneath the crane, had the tide been considerably stronger than was the actual case?

Despite the most careful calculations, mishaps frequently occur in connection with the launching of ships. It is only a few weeks ago that a vessel turned turtle on leaving the ways of an Italian shipyard. A number of years ago a much more serious accident of this same sort occurred on the Clyde, and a large number of men who were at work in the interior of the ship were caught "like rats in a trap" and drowned. When the British battleship *Albion* was launched, the heavy wave thrown up by her impact with the water washed over a low wharf, and hundreds of persons were swept from the wharf into the water, several lives being lost. Every once in a while we hear of a man who is so unfortunate as to be caught beneath the ship as she starts on her initial plunge.

Progress of Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports under date of Sept. 10, 1907, the following percentage of completion of vessels building for the United States Navy:

	Tons.	Knots.		Aug. 1	Sept. 1
BATTLESHIPS.					
Mississippi	13,000	17	Wm. Cramp & Sons	90.32	91.97
Idaho	13,000	17	Wm. Cramp & Sons	83.98	86.01
New Hampshire	16,000	18	New York Shipbuilding Co.	80.00	83.00
South Carolina	16,000	18½	Wm. Cramp & Sons	19.59	21.7
Michigan	16,000	18½	New York Shipbuilding Co.	21.2	24.
ARMORED CRUISERS.					
South Dakota	13,680	22	Union Iron Works	98.	98.9
North Carolina	14,500	22	Newport News Co	86.34	88.99
Montana	14,500	22	Newport News Co	80.	82.58
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	85.	88.72
Birmingham	3,750	24	Fore River Shipbuilding Co.	82.9	87.75
Salem	3,750	24	Fore River Shipbuilding Co.	82.67	86.57
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co.	99.	99.
Viper	—	—	Fore River Shipbuilding Co.	97.	99.
Tarantula	—	—	Fore River Shipbuilding Co.	99.	99.
Octopus	—	—	Fore River Shipbuilding Co.	97.	99.

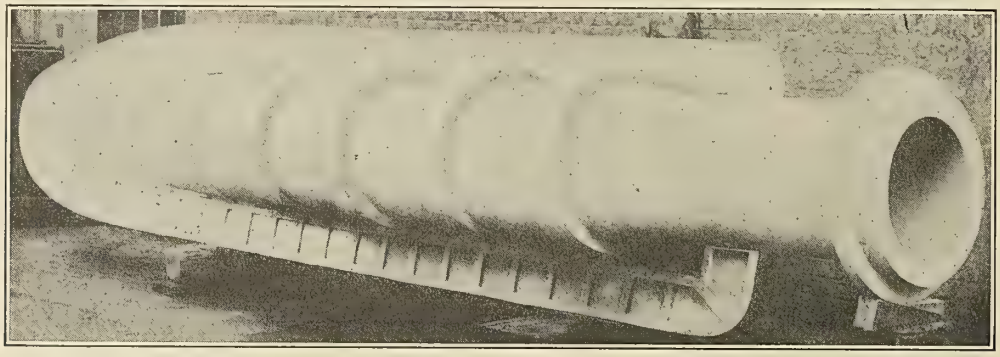
ENGINEERING SPECIALTIES.

Stone's Patent Bronzes.

Apart from the question of price, manganese bronze is generally conceded to be far ahead of all other metals or alloys for the construction of propellers. Twenty years ago this alloy was little known, as marine engineers were not then alive to the advantage to be gained from a propeller much thinner and lighter than one made of cast iron, and one that maintained at all times a sharp cutting edge and clean surface. As far back as 1885 Messrs. J. Stone & Company, Limited, of Deptford, began an exhaustive series of tests and experiments, with the idea of providing a manganese alloy which would be superior to all others in point of strength and durability, at the same time being as little as possible electro active as regards the steel in the hull. That they have succeeded in what they undertook is fully appreciated by marine engineers and naval authorities in England and elsewhere.

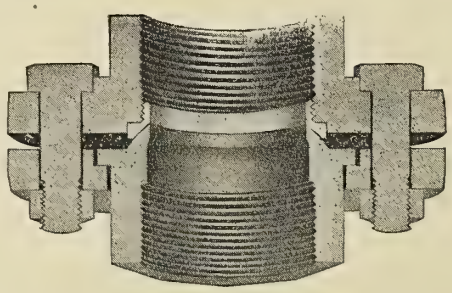
Recognizing the vast importance of the bronze trade in the United States, and fully alive to the advantages to be gained by placing a material on the market the character of which was beyond dispute, the Exeter Machine Works, of Pittston, Pa., has, through the agency of Mr. W. C. Wallace, of New York, who becomes engineer of the marine department, made arrangements with Messrs. Stone for the handling and production there of all their special mixtures of bronzes and bearing metals, as also the manufacture of their patent underline ash and clinker expeller and patent vertical motion windows, as fitted on the *Lusitania* and *Mauretania*. The result of this arrangement is the placing at the disposal of the Exeter Machine Works of all Messrs. Stone's vast experience, laboriously acquired during the last twenty years, as to mixing, handling and preparing the molds for castings of every description and weight, as also the knowledge of the proper furnace to use, and the temperature at which to run the metals, all which points are matters of vital importance if the best results are to be obtained.

It is proposed to supply several grades of bronze, depending on the purpose for which it is required, up to a maximum of five or six tons. The grade of most importance to marine engineers is Stone's "No. 3" bronze, for propeller blades, which has a tensile strength as cast of over 78,000 pounds per square inch, an elastic limit of 39,000 pounds, and an elongation of 25 percent in 2 inches. The propellers of the royal yacht *Alexandra*, described in September, are of this metal. Our illustration shows a stern tube, as fitted on a first-class cruiser of the British navy Another important grade is "No. 4" bronze, especially suitable for forging or rolling into bars or plates suitable for pump rods, propeller shafts of auto boats and all work requiring a metal of great strength, together with freedom from corrosion. This bronze, when cast in sand, has a tensile strength of over 80,000 pounds per square inch, an elastic limit of 66,000 pounds and an elongation of 27 percent. This same bronze, when subjected to cold rolling, has its tensile strength increased to 100,800 pounds per square inch, and its elastic limit to 84,000 pounds, the percentage of elongation in 2 inches being reduced to 10 percent, but when annealed after rolling the tensile strength becomes 76,000 pounds to the square inch, with an elongation of 36 percent.



Kewanee Flange Unions.

These flange unions are made entirely of the highest grade malleable iron, excepting the brass seat, which is made practically integral with the malleable part by the only method which experience has shown to be enduring. This construction gives a very compact fitting, light in weight, and at the same time one that combines extreme strength with rigidity; there is no danger of breaking these malleable flanges in pulling the joints together. Cast-iron flanges, on the contrary, are easily broken in coupling.



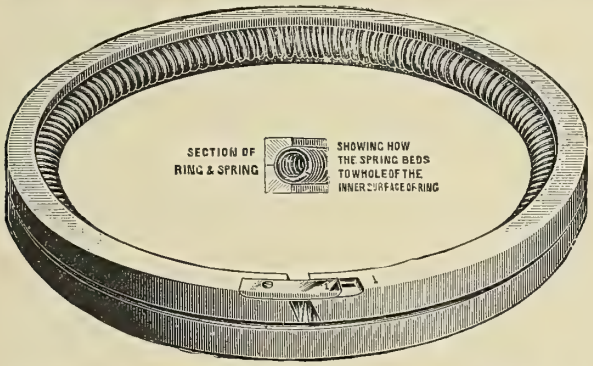
The convex surface of malleable comes in contact with the concave surface of brass; this junction of hard and soft metals

insures a more perfect seat than could be obtained otherwise—it makes no difference whether the pipe alinement is straight or not. Each fitting is given a severe air-pressure test under water, and if not absolutely tight is rejected.

The unions are made in black and galvanized by the Western Tube Company, Kewanee, Ill., in sizes from 1 inch to 10 inches.

The Lancaster Metallic Packing.

This packing, which is placed on the market by Lancaster & Tonge, Limited, Pendleton, Manchester, is designed for steam pressures up to 150 pounds per square inch, while for pressures over this figure the packings are fitted in tandem in two



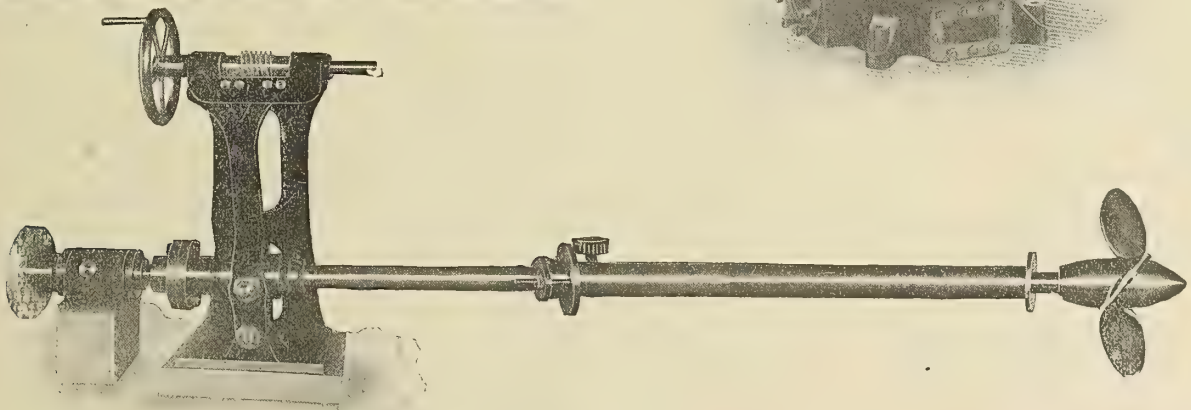
or more sections, as may be necessary. At the front of the casing are placed two washers forming a ball joint. Metallic blocks, lined with anti-friction metal, are placed inside this joint and pressed against the rods by wire springs which run entirely around them, forming a sort of constriction, and keeping the rod steam tight. The springs are made of square steel in halves, and may be screwed together at one point and hooked at another. The screwing allows of such adjustment in length as may be necessary, and also for adjustment in tension to suit different working pressures.

It is claimed that these packings, which are simple, are perfectly efficient and, if properly lubricated, will work with a minimum of friction. Their durability is shown by the fact that in some cases they have operated for upwards of ten years without sufficient wear to require renewal. All the working parts are interchangeable, and may readily be replaced should occasion demand.

Gaines Reversible Propellers.

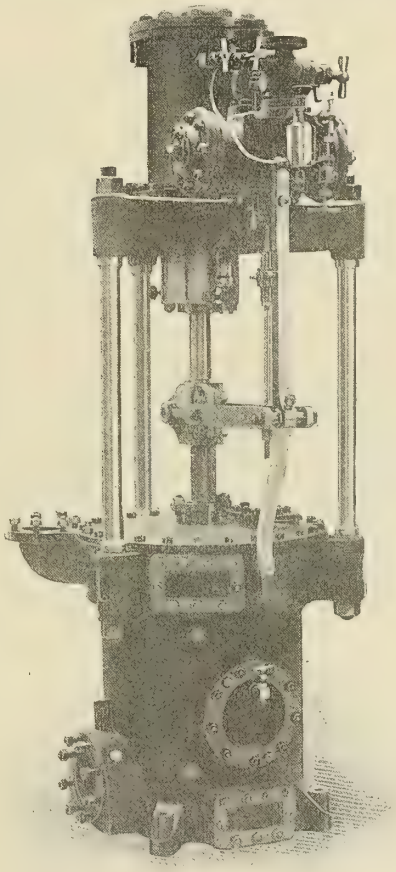
The illustration shows a three-bladed propeller with heavy wheel and worm control, for reversing, as supplied by the Gaines Reversible Propeller Company, Limited, Stonecutter street, London, E. C., to the Egyptian government for a small boat to be operated on the Nile. This arrangement makes it possible to adjust the propeller blades to any angle desired, and hence to give the propeller any desired variation of pitch, although, of course, it would not be possible to keep up best propeller efficiency with any considerable variation of pitch. It is said that the device is so well contained as to be proof against getting out of order, and, as the mechanical device of the wheel and worm gives a very heavy operating force, the control is easily effected. The speed of the boat can, to a certain extent, be regulated by this device without any necessity for altering the adjustment of the engine.

The wheel is of polished gunmetal, the worm of phosphor bronze, and the standard a casting enameled dark blue. This device is supplied in a large variety of sizes.



The Weir Monotype Air Pump.

This air pump, put on the market by G. & J. Weir, Limited, Cathcart, Glasgow, represents the latest improvement in marine auxiliary machinery, and forms the culmination of a long series of experiments, and the successful development of a type of air pump which it has long been their endeavor to produce. To secure on a single direct-acting air pump the regular and



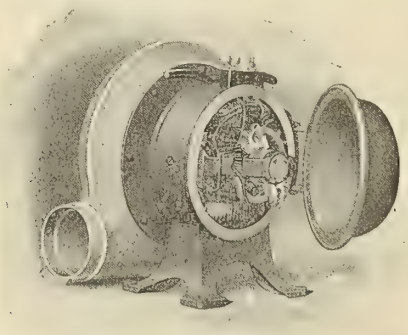
uniform working of the beam connected type, where the balance of the movement is got from the inter-connection of the two rods, and to produce a design capable of dealing with the varying and peculiar character of the air pump load, was a difficult problem. Before putting it on the market, they have had the type fitted on a number of vessels, to obtain actual sea-going experience of its performance under all classes of conditions. The working of the pumps has been carefully watched, with the result that they have been found to fulfil every requirement with reliability and efficiency.

They are, therefore, supplied for any air pump service up to single units suitable for 6,000 horsepower. For units of power above this the adoption of the twin type is recommended, from commercial considerations, as economy in weight and space become less pronounced in the larger units.

The designs of these pumps have been standardized for all classes of vessels, and the extra cost over air pumps driven from main engines is now such as to be fully counterbalanced by the numerous advantages gained. The advantages of the Monotype single air pump over the twin type are chiefly in respect to weight, space occupied, and lower cost, while it is at the same time as efficient and reliable. The twin type and Monotype designs cover practically the whole field of ordinary marine air pump requirements.

A Sturtevant Ventilating Set.

The motor-operated fan illustrated is placed on the market by the B. F. Sturtevant Company, Hyde Park, Mass., and is particularly fitted for marine work, as a small ventilating device. It is made in two sizes, of which the smaller consists of a No. 00 Monogram fan and a motor of one-sixth brake horsepower. This motor is series wound, and, with a nominal speed of 3,500 revolutions per minute, will force 180 cubic feet of air against a pressure of 2 ounces. The motor is



furnished usually for a voltage of 220, though it can be supplied for a lower pressure. It draws power at full load to the extent of 300 watts, or about 0.4 horsepower. The entire set weighs only 75 pounds, making it easily transportable. It has the advantage of being convertible, with the discharge in any direction, while the motor can be placed on either side of the fan. The motor is placed in a dust-proof case accessible by means of a swinging door. The air outlet has a diameter of 2¾ inches.

The larger size consists of a No. 0 Monogram blower in conjunction with a one-fourth brake horsepower motor. This delivers 425 cubic feet of air per minute at 2,200 revolutions under this load, and draws 320 watts, or 0.43 horsepower.

TECHNICAL PUBLICATION.

Laying Out for Boiler Makers. Size, 10 by 13 inches. Pages, 191. Illustrations, 432. New York, 1907: *The Boiler Maker.* Price, $4 (16/—).

This book, which is very largely reprinted from the pages of *The Boiler Maker,* has been compiled for the purpose of giving the practical man in the shop the information necessary to enable him to lay out in detail different jobs of boilers, tanks, stacks and irregular sheet metal work. While the work of laying out, as it is carried on in the boiler shop, requires considerable technical knowledge in addition to that gained by a practical mechanic in the course of his experience in the shop, yet a complete mastery of such subjects as geometry, mechanics, and other branches of elementary mathematics, is by no means essential for the carrying out of the work. The practical application of certain of the principles involved in these subjects is, however, very important, and has been explained in a practical way in connection with different jobs of laying out, which form a part of the every-day work in every boiler shop.

The table of contents shows eight chapters, as follows: The Subject of Laying Out; Triangulation; How to Lay Out a Tubular Boiler; How to Lay Out a Locomotive Boiler; How to Lay Out a Scotch Boiler; Repairing Locomotive and Other Types of Boilers; The Layout and Construction of Steel Stacks; and Miscellaneous Problems. The chapters taking up the detail layouts of different types of boilers give not only the methods for laying out the actual boiler, but also the rules for determining the size, shape and strength of the different parts. These computations are given in considerable detail in the case of the plain tubular boiler, because this involves problems of a very general nature, which may be applied to most of the other types.

The cuts, which, as above mentioned, are extremely numerous, are very clear and well chosen for the object in view, including, as they do, very many details in the way of line drawings, with occasional half tones for illustrating the various types described.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 382.—I am in charge of two boilers of 100 horsepower each, one of which carries a pressure of 85 pounds per square inch and supplies steam for an engine; the other boiler carries a 60-pound pressure and supplies steam for dye tubs, wash vats, dry kiln, and for heating the factory. The boilers are supplied with water from one injector taking steam from the high-pressure boiler and feeding through the blow-off. Every six weeks the boilers are washed out and we get from the low-pressure boiler nearly a pail full of mud, while the high-pressure has only a handful. Why should one accumulate more mud than the other? W. H. C.

A.—There seems to be no plausible reason for a greater deposit of mud in the low-pressure boiler. The difference in temperature between the two is only twenty degrees, and there is no precipitation in the character of mud which would be more soluble at the higher temperature. It may be that certain other conditions not stated above enter into the question, such as a difference in circulation in the two boilers, in such a way that the mud would be deposited at different points, so that in the high-pressure boiler it may be gradually accumulating at some point which has not yet come under observation. J. B. S.

Q. 384.—Would you kindly give calculations showing how to arrive at sizes of cylinders for a triple expansion engine of a given horsepower, how to fix ratio of expansion, working pressure, etc.? J. T.

A.—The best way to illustrate this point is to go through the calculations for a definite horsepower. Let us assume that it is desired to design a triple expansion engine of 1,000 horsepower, for the propulsion of a ship. General practice gives a total ratio of expansion for a triple expansion engine of this kind as about 10 or 11. Suppose we take it at 10.5, and consider that the expansion in the high-pressure cylinder, taking account of the amount of clearance and the point

of cut-off, is 1½. This makes the ratio between high-pressure and low-pressure piston areas equal to 10.5 ÷ 1.5, or 7.

The mean effective pressure for the whole engine is given by the usual expansion formula:

$$p_m = f\left(p_1 \frac{(1 + \text{hyp. log. } r)}{r} - p_b\right)$$

In this formula p_m is the mean effective pressure referred to the low-pressure cylinder; p_1 is the initial steam pressure in the high-pressure cylinder; p_b is the back pressure against the low-pressure piston, and is usually considered as about one pound higher than the condenser pressure; f is a factor taking account of the reduction in mean effective pressure occasioned by losses due to wire drawing and losses in passing from one cylinder to the next, as shown by the rounding off of the corners of the cards, etc.; (in triple expansion engines this factor is taken usually at from 60 to 70 percent; in the present instance, we will place it at 65 percent;) r is the ratio of expansion throughout the whole engine. It should be remembered that the pressures mentioned are absolute pressures, or pressures above a vacuum. This means that they are 14.7 pounds higher than the gage pressures.

If we assume an initial absolute pressure of 150 pounds per square inch, and a back pressure of 4 pounds, the expression within the brackets becomes

$$150\left(\frac{1 + 2.3513}{10.5}\right) - 4 = 150 \times 0.319 - 4 = 43.85$$

Taking account of the card factor, our reduced mean effective pressure becomes 28.5 pounds per square inch.

The formula for horsepower is:

$$H = \frac{2\,p_m\,L\,A\,N}{33{,}000},$$

where L is the length of the stroke in feet; A is the area of the low-pressure piston, and N is the number of strokes per minute. It should be noted that this latter is double the number of revolutions. It will further be noted that $2\,LN$ is the piston speed in feet per minute, which may be assumed to be 750. Using our horsepower equation, therefore, and inserting all known values, we have:

$$1{,}000 = \frac{750 \times 28.5 \times A}{33{,}000}$$

Solving this equation for A, we obtain 1,542 square inches. This corresponds with a diameter of about 44½ inches for the low-pressure cylinder. Our ratio between high-pressure and low-pressure was given above as 7. This would give the high-pressure cylinder an area of 220 square inches, corresponding with a diameter of 16¾ inches. If we assume that the ratio of low-pressure to intermediate cylinder area is the same as the ratio between intermediate and high-pressure, this would give us an intermediate cylinder area of 583 square inches, corresponding with a diameter of 27¼ inches.

We have yet to determine the length of stroke and number of revolutions per minute. It is not unusual to make the length of stroke about equal to the diameter of the intermediate cylinder, say 27 inches, in which case the number of revolutions per minute becomes 167. If, however, we make the stroke 30 inches, which would be quite usual for an engine of this size, the revolutions become 150 per minute. In any event, this latter figure would depend to some extent upon considerations of propeller design, etc.

The piston speed varies greatly in different classes of engine. For a freighter, it is usually below 600 feet per minute, and may go as low as 450; for a torpedo boat, on the other hand, it is often above 1,000 feet per minute, and may reach 1,200. The figure chosen should be appropriate to the service to be rendered. Of course, the higher the piston speed, the smaller the corresponding cylinders, and vice versa.

Q. 385.—I have an auxiliary yacht with a 12-horsepower Leader engine. Not being able to tilt the engine or to put it in the middle of the cabin in order to get a direct lead of shaft, I have installed a universal coupler, working on a 20-degree angle, which operates very unsatisfactorily. Would bevel gears, or some other method, give better results? W. B. B.

A.—The universal joint in the shafting of motor boats is entirely feasible and practicable. Where these joints or couplings have failed it has been due to faulty design or poor installation, or both. A common fault is defective lubrication. An angle of 20 degrees is rather unusual for the propeller shaft, and there would undoubtedly be a great loss in propulsive efficiency at this angle. This sort of device, however, is used in the motor boat *Skedaddle,* where 175 horsepower is transmitted, and has given entire satisfaction.

Gearing cannot be recommended, because the least deviation from the true alinement would cause it to break. Besides this, gearing is very noisy, and the friction in gears is immensely greater than in a universal joint or coupling.

H. J. G.

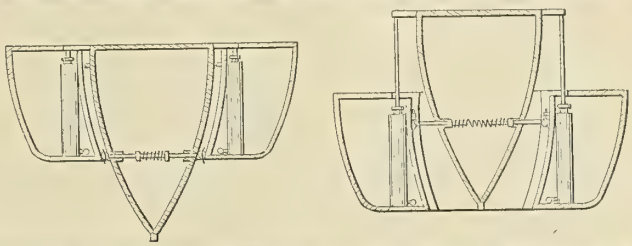
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

861,045. BOAT. WILLIAM J. NOLAN, ST. LOUIS, MO.

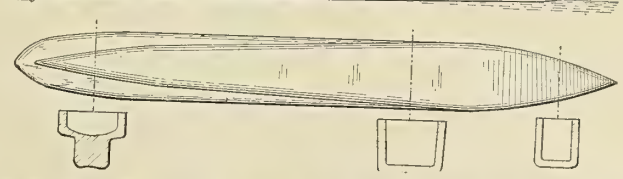
Claim 1.—A boat comprising an outer hull and an inner hull, said inner hull mounted to move vertically with relation to the outer hull, and



provided with yieldingly mounted rollers, and springs for holding the said rollers in contact with the outer hull. Four claims.

861,134. VESSEL HULL. CAREY A. MANKER, PEARL, ILL., ASSIGNOR TO MANKER-HEAVNER NAVIGATION CO., OMAHA, NEB., A CORPORATION OF ARIZONA.

Abstract.—The main object of the invention is to provide a vessel hull which is so shaped that it will overcome the resistance of the water through which it travels, thereby enabling the vessel to be propelled with a minimum expenditure of power. The bow of the hull is pointed, and normally lies above the surface of the water, the bottom of the bow curving upwardly so that the bow of the hull will have a tendency to climb up over the waves, and thereby tend to displace water downwardly underneath the bottom of the hull, which is concaved transversely and preferably longitudinally, so as to provide longitudinally



curved surfaces, which, as near as possible, express diagrammatically nature's law of accelerated motion. The portion of the hull which is submerged in the water is of greatest beam adjacent the bow and thence diminishes gradually in width toward the stern of the hull. Three claims.

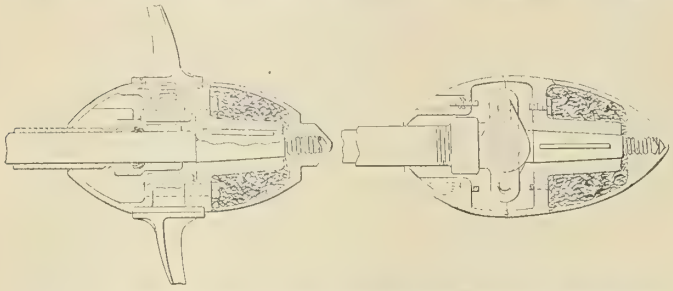
861,478. STEERING MECHANISM FOR SHIPS. AUGUSTUS W. OTTIGNON, ST. LOUIS, MO.

Abstract.—The invention relates to steering mechanisms for ships and has for its object to provide a supplemental steering mechanism to be carried by the ship, and to be used when the ordinary steering mechanism becomes disabled.

Claim.—The combination of a circular buoyant steering member having one face convex and the other plane, a drag cable secured to the plane face of said member near the periphery thereof, and a controlling cable having connection with said latter face at a plurality of points. One claim.

861,612. REVERSIBLE PROPELLER. ALBERT B. SHULTZ, BUFFALO, N. Y.

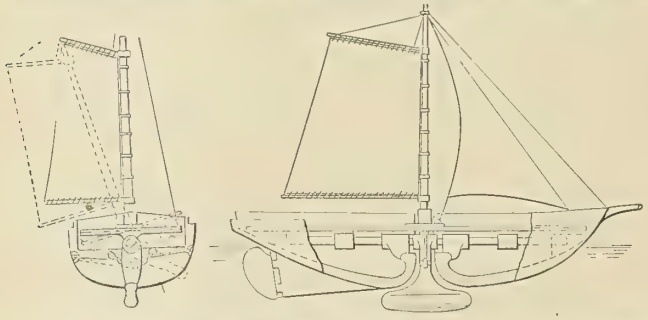
Claim 2.—A reversible propeller comprising a hub having bearings, wrists journaled in said bearings, blades having screw shanks at their inner ends which engage with screw sockets in said wrists, a flange arranged at the base of each blade and having a curved slot which is provided at intervals with enlargements, a locking screw engaging said wrist, and having an oblong head arranged in said slot and adapted to



engage its wide part with any one of said enlargements, a driving shaft connected with said hub, and means for adjusting said blades operatively connected with said wrists. Five claims.

861,894. NAVIGABLE VESSEL. JAMES P. POOL, NEW YORK.

Abstract.—The invention has for its object to provide vessels of improved stability in their course through or upon the supporting element, whereby and wherein the customary careenings, gyrations and oscillations of such vessels as at present constructed may be substantially overcome. A supporting member is provided, which rests directly upon or moves through the supporting medium; a load-carrying member independent of, but connected with the supporting member, and capable of movement relative to the supporting member; and a ballast or counterpoise member which is operatively connected with the load-



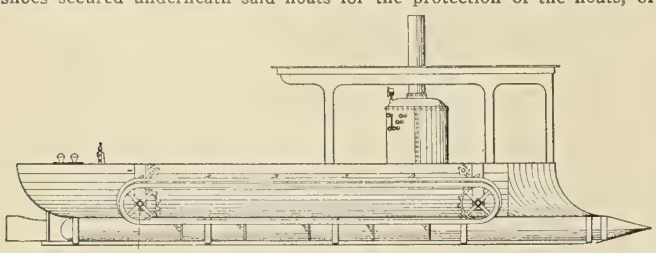
carrying member in such manner that it shall execute movements simultaneously with those of the load-carrying member, and such as shall compensate for the careenings, gyrations and oscillations of said load-carrying member. Eleven claims.

863,735. DEVICE FOR PREVENTING RACING OF MARINE ENGINES. ALEXANDER J. MACLEAN, NEW YORK.

Claim.—1. In a device for preventing the racing of marine engines, a solenoid having a plurality of separate coils, means actuated by the core of said solenoid to control the action of the throttle valve to thereby govern the speed of the propeller, and means automatically actuated by the rise and fall of the vessel for energizing the coils of the solenoid. Four claims.

863,747. COMBINED ICE AND WATER BOAT. JAMES A. NORTON, ODEBOLT, IA., ASSIGNOR TO PETER E. NORDELL, TRUSTEE, KIRON, IA.

Claim.—1. The combination with a flat bottomed boat, a series of floats or hollow tubes secured together upon which the boat is mounted, shoes secured underneath said floats for the protection of the floats, of



endless chains run by sprocket wheels on each side of the boat, an engine for the operation of said sprocket wheels, paddles for the propulsion of the boat pivotally secured to said chains, means for holding said paddles vertically rigid when in the water, and means for raising and lowering the sprocket wheels and adjusting the paddles with reference to the water. Two claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

7,286. ELASTIC-FLUID TURBINES. AKTIESELSKABET ELLING COMPRESSOR CO., CHRISTIANIA, NORWAY.

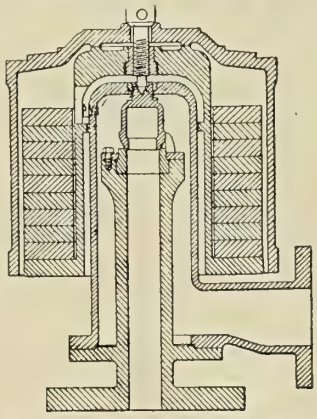
Relates to means for preventing suction disturbances in the neighborhood of those blades of a fractional supply turbine that have just left the inlet aperture. To allow a gradual retardation to take place in the velocity of the steam in those blade channels that have just left the inlet aperture, auxiliary blades forming retardation channels are arranged at the forward side of the inlet and are connected by a passage with the wheel chamber. In a modification, a circulation passage with a collecting-plate connects the two sides of the wheel. The last inlet guide is cut away near to the wheel and one or more of the channels have shortened sides allowing a gradual mingling between the steam currents. The retardation channels may have only a single curved guide. In another modification, a sliding valve is used when the steam supply is small to cover some of the ordinary passages and make them act as retardation passages. Circulation passages may be connected to these ordinary passages.

7,459. SHIPS. DRIVING GEAR FOR SCREW PROPELLERS. E. J. DUFF, LIVERPOOL.

The engine drives a propeller shaft passing through a tunnel in the ship, and its rotative effect is augmented by utilizing the power which is in the head of water required to float the ship. Upon the same shaft as the prime mover is fitted a turbine or equivalent motor, driven by the head of water above the inlet. Propellers eject the tail waters and thereby give the forward propulsive thrust. Instead of the propellers, a rotary pump may be used. This arrangement may be duplicated with twin screws. In a modification, two screw propellers on separate shafts are driven by separate engines and turbines, the turbines discharging into a common tunnel provided with a rotary pump driven by a prime mover.

8,268. SAFETY VALVES. J. HOPKINSON AND J. HOPKINSON & CO., HUDDERSFIELD.

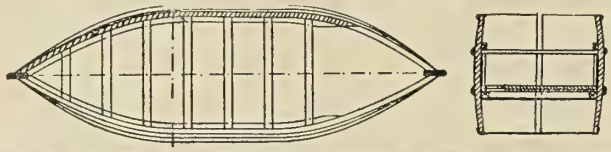
A dead weight safety valve is constructed so that the load is lower than previously, and is preferably below the valve seat; the steam is



discharged into a dome above the outlet pipe; the weight holder is provided with a central pivotal support which rests on the spindle; the weight holder and cover are connected by a central connection, and the valve spindle is shortened. In the form shown, the valve discharges into a cylindrical chamber in which the inlet is arranged, the steam escaping between the inlet and the chamber. The spindle is guided in its movements by an opening in the chamber. The weights are arranged on a holder. The holder and cover are so formed that the center of gravity of the load is below the valve seat.

8,307. SHIPS' BOATS. HULLS. M. BUTCHER, LEEDS.

The sides of a ship or boat are continued for some distance below the bottom, which is approximately flat. A large body of water is thus inclosed, reducing the rolling and the liability to capsize. These ex-



tensions are made to meet at the stem of the vessel, and are carried around the stern only in skeleton form, leaving a large opening on each side.

8,347. CAPSTANS. W. P. THOMPSON, LIVERPOOL.

Comprises construction and arrangement of electrically operated capstan. In the center of the pedestal, which also forms the stator of the motor, is a pivot on which turns a drum firmly connected to the rotor by pins. The drum may be raised for inspection by a handle keyed to a screw having the pivot as its nut. The starting switch is constructed to make and break suddenly without sparking, and independently of the speed of movement of the operator. On depression of the foot lever, the barrel is swung around by a spring, and the movable contact is moved until it reaches the fixed contacts. The switch is arranged in an oil chamber or casing.

8,673. SHIPS. PROPELLING BY WATER JETS. K. J. A. ISAKSON, STOCKHOLM, SWEDEN.

In boats having propelling machinery which is not reversible, motion astern is obtained by means of water jet apparatus comprising a bent pipe open at each end. The pipe is penetrated by a number of chan-

nels directed ahead, and may be fixed or revolublé. The driving medium is supplied by the pipe, and is controlled by a stop cock. The inlet end of the pipe is of broad section, with a rapidly widening opening. This apparatus is used in conjunction with screw propellers and paddle wheels for diminishing the speed of the vessel, or for completely reversing its motion.